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Dr. Sheard was formerly editor of the *American Journal of Physiological Optics* and for many years director of the Department of Biophysics, The Mayo Foundation. The book contains 83 illustrations, 476 pages, $15.00.

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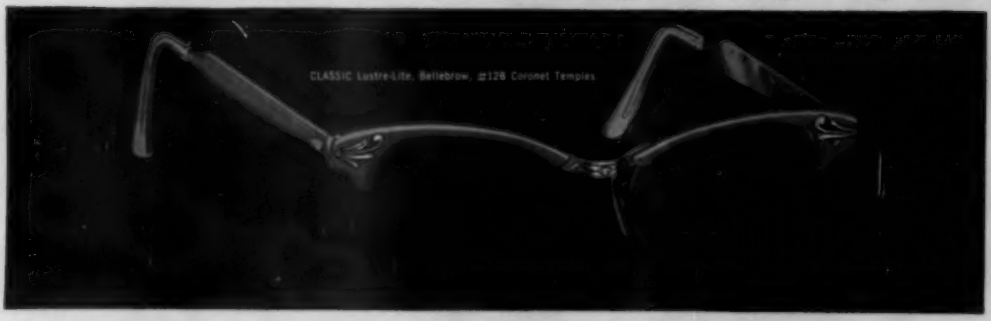

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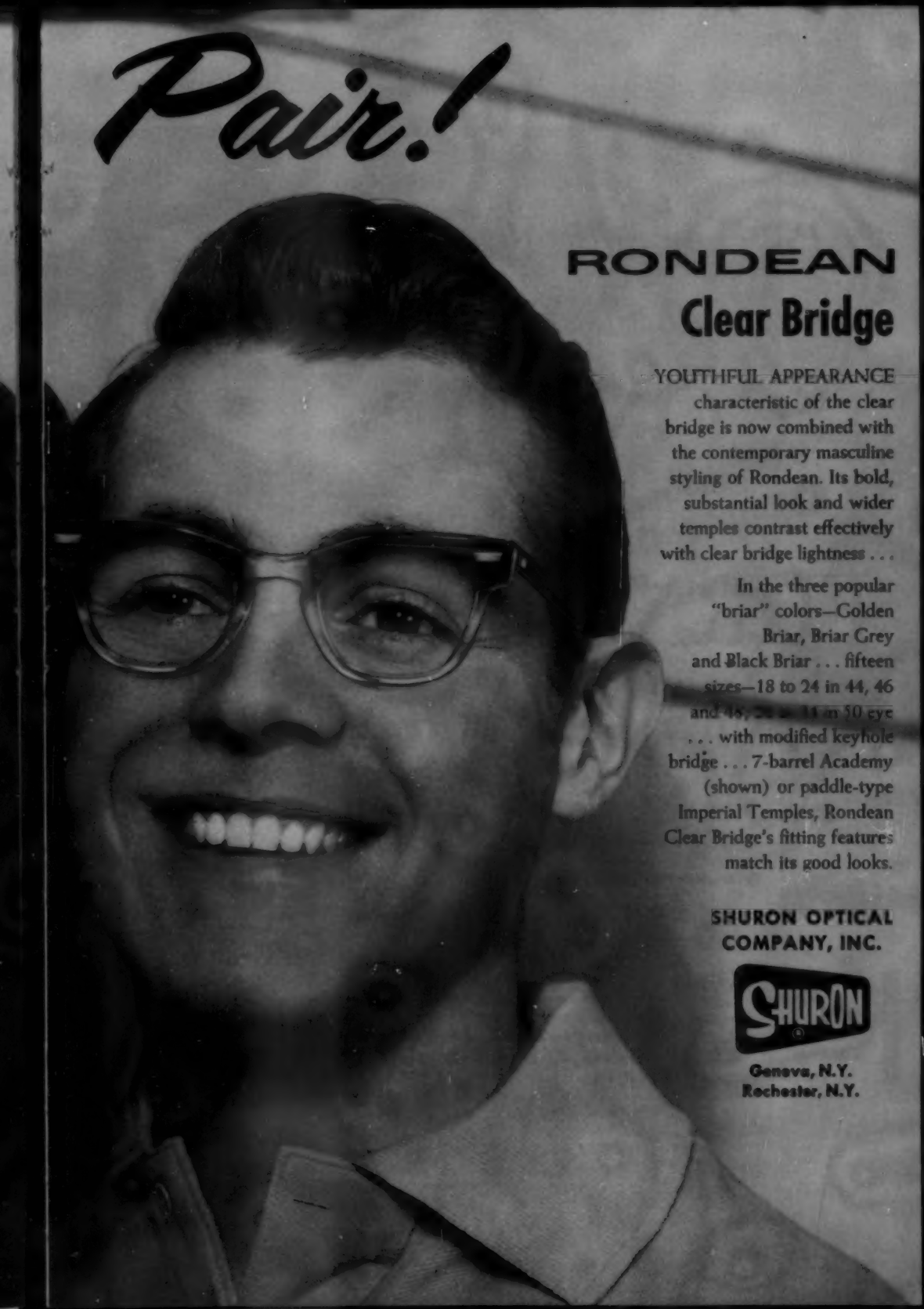
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AN ESTIMATE OF THE HEREDITARY COMPONENT OF MYOPIA*

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One of the oldest and most difficult problems faced by the biological and medical sciences is that of determining the contribution of heredity and environment to the behavior and development, in its broadest sense, of the organism. These two factors may be considered to underlie all aspects of life and, consequently, are intimately concerned with the developments and changes which occur in vision and the visual system and, in particular, in myopia.

Varying amounts of emphasis and work have been directed toward the solution of this problem in different countries and at different times in the same country. Curiously, and perhaps because of the pragmatism which underlies American thought, relatively little effort has been expended toward the solution of this problem in the United States and, especially, is this true of the last two decades. The general attitude seems to be the acceptance of the fact that both factors interact to affect behavior and development; that it is difficult, if not virtually impossible, to separate the two; and that it is more fruitful to study the end result and the obvious factors which appear to lead to it without trying to determine whether these factors are hereditary or environmental in nature.

This approach has obvious pragmatic value, but, since no attempt is made to evaluate the relative contributions of heredity and environment empirically, any assignment of these obvious factors to either major category is based on a-priori considerations rather than obtained evidence. Unfortunately, once such an assignment has been made it is treated as though it were an experimentally verified fact and future behavior and thinking are brought into line with this assignment. The

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*Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 9, 1957. For publication in the July, 1958, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
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behavior-directing influence of such an assignment is clearly evident in the current thinking about the nature of myopia and how it should be handled.[17]

If one assumes, and this must remain an assumption until verifiable evidence is gathered to support it, that myopia is primarily hereditarily determined and that environmental factors play little or no role in its development, then one would clinically correct myopia and tell the parents of the child that there is nothing to be done about the situation. The myopia will likely get worse as the child grows older but will eventually be arrested as the individual approaches adulthood. In the meantime the child should be examined at least once a year and the spectacles changed.

If one takes this point of view, which may be correct but has not been demonstrated to be so, there is obviously no reason to study the nature and development of myopia or the relative importance of hereditary and enviromental factors since we have already decided that it is hereditary, and about the only thing that one can do is to select the proper parents. This is a conservative and complacent stand and, if in the future it should be proven incorrect, and the clinician must face the fact that he has been derelict in his duty to help his patients, he can always plead ignorance. Such attitudes and thinking made syphilis a just penance of the Lord and mental illness an infestation by devils, and, in both cases, something which is so and must not be studied or questioned. Unfortunately, the person who holds such a belief has much company.

If on the other hand one takes the point of view that myopia is primarily the result of the operation of environmental factors, and that the eye can adjust to environmental stresses just as well as the teeth, the bones, the heart, the skin, and in fact just about any part of the body, then he is likely to try to modify the environment of the child showing an early myopic pattern. Since this point of view has not been completely supported either, and there is a lack of sufficient evidence as to which, if any environmental factors are actually related to myopia,[16] the environmental factors he manipulates will depend on his own biases and may be calcium intake, lighting, study position, amount of near work, etc. In any case, as long as the manipulation is in line with the present evidence available he may not be effecting the progress of the myopia, but neither is he harming the child; he is trying to do something to help the child.

To go beyond these guessing stages and tackle the problem of the contributions of heredity and environment to the development of

myopia, one has available two approaches, the correlational and the experimental. These two methods are not equally effective and are not interchangeable but rather are complementary. If two variables are thought to be related on some logical grounds based on other evidence, it is possible to determine the magnitude of this relationship by correlating measures of the two variables. Since the method used to correlate two sets of measures is purely mathematical and completely independent of the nature of the variables and the measures, it is essential to have other evidence to support a relationship between the variables. Correlation is thought to indicate the influence of factors which underlie both variables: with no common factors the correlation coefficient would be zero and with all factors common to both variables would approach plus or minus one as a limit. Correlation can only indicate magnitude of relationship between common factors and cannot determine which factors are common. The latter can only be determined by the application of the experimental method.

If the experimental method is the most reliable and valid means of gathering information and must always be the final criterion concerning the size and nature of a relationship, why use the correlation approach at all? By its very nature the experimental approach requires a considerable expenditure of time and effort to test even the simplest hypothesis whilst the correlational approach can answer the question as to whether there is or is not a relationship with a minimum expenditure of time and effort. Thus in the ideal approach the correlational method is used first to determine whether variables are related and to what degree. Then the experimental method is used to determine the exact nature of the variables and the relationship.

These same considerations hold when these methods are applied to the problem of separating the contributions of heredity and environment to the development of myopia. Utilizing a technique developed by Karl Pearson and used in his studies on eugenics,[13] it is possible to correlate similar measures taken on siblings where the correlation involves the similar scores such as heights in inches of pair of siblings. This is slightly different than the usual correlational approach in which two different measures on the same individual are related. This method may be contrasted with the experimental approaches to the same problem which involve either control of heredity through the use of sets of identical or one-egg twins and a variation of the environmental factors or control of environmental conditions and variation of heredity by using subjects from different family groups.

If the relationship between different amounts of near-work and the

development of myopia is to be investigated with the co-twin-control experimental design, one member of each pair would be placed in an experimental group and the other in the control group. Each of three experimental groups would be subjected to one degree of near-work: little, medium, and great amounts. If there were no differences between the three experimental groups and between these and the control groups, we could conclude that near-work has no effect on the development of myopia, and we would expect to find the same incidence of myopia in the experimental and control groups since they have the same heredity. On the other hand, with no myopia in the control groups but degrees of myopia in the experimental groups which increased as the amount of near-work increased, the conclusion is tenable that the development of myopia is related to near-work. Further, if the degree of myopia developed with large amounts of near-work approximate that found in the population at large, it is possible to conclude that heredity plays no role in the development of myopia.

A comparable test could be set up by subjecting individuals with different hereditary backgrounds to the same environment. If environment plays the major role, these subjects should all have the same visual pattern providing they had similar patterns before starting the experiment. In so far as heredity plays a role, their visual patterns should become different in spite of the similar environment, and, if the differences approximate those found in the general population, then the conclusion that environment plays little or no role is warranted.

The impossibility of applying the latter approach to human subjects is immediately obvious, and the difficulties involved in the co-twin approach become obvious when one considers that there are less than 600 thousand identical twins in the 170 million population of the United States.[11] The task of locating and arranging for some of these to be separated into two groups and subjected to different conditions is staggering to the imagination. The only other approach is to locate identical twins who have been accidentally separated and subjected to different environments approximating the desired experimental conditions. In twenty-five years of studying twins Newman has been able to locate twenty pairs of one-egg twins who had been reared in different environments, not necessarily different in terms of visual environment.[11] Neither of these procedures is feasible for studying the effects of differing visual environments.

Even though it is not feasible to tackle our problem by the experimental approach with human subjects, it is still possible to apply the correlational method. This has been done with 207 sibling pairs avail-

able in the Pullman Study.[18,19] These pairs are made up of boys and girls between the ages of 5 and 14, inclusive, and represent same-sex and mixed-set pairs. Since there were not enough same-sex pairs to make correlation desirable, it was necessary to use the mixed pairs. However, through the use of age groups 5 through 14 sex differences have been minimized with respect to the variables correlated: height, interpupillary distance, weight, IQ and static refraction. The studies of Greulich[4] and of Shuttleworth[15] both indicate that there is no significant difference between the sexes in either height or weight within these age ranges. Similarly, there are no sex differences on the Stanford Binet.[10] While the data of the Pullman survey shows no significant sex differences in interpupillary distance, unfortunately, the same equality cannot be claimed for the refractive error sex difference since the girls showed an earlier incidence of myopia and higher rate than the boys until the age of 12 when the boys catch up and slightly exceed the girls. Since the two curves are similar when age differences are removed, this sex difference will have a relatively small effect on the final correlation because age will be equalized by a statistical procedure.

The correlation between pairs of siblings on all four measures would be simple enough if all subjects were adults. Theoretically, if a measure such as height were determined primarily by heredity, we would expect a much higher correlation between siblings than between randomly selected subjects. In fact, the correlation between randomly selected subjects should be zero, whereas the correlation between identical twins should approximate one, actually found to be +0.93 by Holzinger.[5]

In dealing with children who have not reached their maximum development any relationships may be obscured by age differences, and it becomes necessary to partial out the regression of the desired measures on age. This may be done by determining the relationship between the measure, such as height, and age and predicting the adult height from the regression equation which may be set up. These predicted scores may then be used for the correlation between heights of siblings. It is not actually necessary to predict each score since the mean regression may be partialled out by the use of the following formula in which the subscripts 1 and 3 stand for the desired measure and age respectively of one group and 2 and 4 stand for the measure and age of the second group.

$$r_{12 \cdot 34} = \frac{r_{12} - r_{13}r_{23} - r_{14}r_{24} + r_{13}r_{24}r_{34}}{\sqrt{1 - r^2_{13}} \qquad \sqrt{1 - r^2_{24}}}$$

This formula, which determines the relationship between any two sets of measures with age held constant, was applied to all of the measures which varied with age. Even though IQ is generally considered to be relatively independent of age and sex, the formula was applied to the total group. The smaller N for IQ (148) and determined independence of age together with known independence of sex did not justify a further breakdown. The partial and zero-order correlation coefficients are presented in Table I. The zero-order correlations were determined by gross-score formulas with the older sibling in one group and the younger in the other group. Several of these were compared with intraclass correlations based on the same data and found not to differ more than 0.02.

TABLE I
Correlations between siblings with age held constant
Zero-Order Correlations in Parentheses*

Groups	Number of pairs	Height	Weight	Interpupillary distance	Refractive error—OD**	IQ
Male Sibs	56	0.37	0.08***	0.49	0.12	
		(0.15)	(0.11)	(0.40)	(0.05)	
Female Sibs	43	0.48	0.36	0.46	0.24	
		(0.20)	(0.13)	(0.39)	(0.16)	
Like-Sex Sibs	99	0.43	0.23	0.48	0.15	
		(0.16)	(0.12)	(0.39)	(0.08)	
Mixed-Sex Sibs	108	0.31	0.29	0.36	0.13	
		(0.09)	(0.08)	(0.15)	(0.13)	
Total	207	0.36	0.25	0.43	0.14	0.35
	(For IQ N = 148)	(0.09)	(0.07)	(0.25)	(0.10)	(0.35)

*All coefficients have a positive (plus) sign.
**Equivalent sphere of error determined with fogging technique (see 18).
***A near-significant (0.5% level) correlation (0.22) was found between weight of one sibling and age of the other rather than the zero correlation expected. If the average correlation found for this relationship (0.04) is substituted, this value becomes 0.39.

The sibling pairs were then broken up and new pairings were randomized to check on the predicted correlation of zero for random pairings. These correlations were calculated for height as 0.03 and for static refractive error as 0.05.

DISCUSSION

Before trying to interpret these results a comparison will be made between the correlation coefficients of height, weight and IQ obtained in this study with those found in similar studies. Most of the studies[1, 2, 12] which have related height in siblings have obtained values ranging from +0.50 to +0.60. Weight has been less frequently studied and the only comparable value obtainable is +0.58 for like-sex siblings.[12] The range of correlation values for Stanford-Binet IQ's is +0.37 to

+0.50.[3, 12] From these comparisons it is apparent that the values obtained in this study fall below the range of values obtained on other studies but are usually close to the lower limit of the range except for weight. This tendency to fall at the lower limits may be due to the use of the partial correlation technique which has not been used in the studies cited above. Most of these studies correlated measures made at the same age level rather than partialling out age when the measures were taken at different age levels. Further, some of the values presented above are based on same-sex siblings which generally are higher than for opposite-sex siblings.[3]

The thinking underlying this approach to the study of nature and nurture holds that those measures which are primarily hereditarily determined will show higher correlations than those not so related when pairs ranging from no relation to identical twins are taken from a comparable environment. Thus we find the highest correlations between physical measures such as height, +0.93, weight, +0.92, and head width, +0.89, with identical twins; lower correlations, e.g. height, +0.65, weight, +0.63, and head width, +0.55, with fraternal twins and still lower values for siblings and no correlation for random pairs.[12] Pearson[13] has suggested that a correlation of +0.52 obtained with an unselected environment indicates a purely hereditary determination. The environment in the Pullman group is known to be selected and, consequently, no attempt should or will be made to place a proportional value on the obtained correlations with respect to the relative contributions of heredity and environment.

A comparative interpretation can be made in terms of the values obtained on the Pullman group alone. On good logical grounds it is possible to rank the measures used in terms of decreasing importance of hereditary component as height, interpupillary distance, weight and IQ. Both weight and IQ are more likely to be influenced by environmental factors than either height or interpupillary distance. If this order can be justified, then it follows that static refractive error must be even more susceptible to environmental influences than even IQ and weight. The obtained value makes it highly unlikely that static refractive error is primarily hereditarily determined and lends considerable support to the environmental influence position.

It is possible to marshal still other evidence to support the view that environmental factors play a considerable role in the development of myopia, other than the demonstrated relationship between degree of myopia and amount of near-work.[16]

This evidence is based on experimental studies made in the early

1900's by Levinsohn and his supporters and detractors.[6, 7, 8] These experimental results, repeated and verified several times, have never been given the prominence they deserve because they were used to support a theory of myopia development which most ophthalmologists think is too silly for words. Levinsohn had the idea that myopia resulted from the effects of gravity pulling the eye downward when the person was reading and stretching the sclera since the optic nerve resisted the downward force of gravity. This theory overlooks the other supporting muscles, fat pads, bones and tissue which also serve to support the eye and help to overcome the effects of gravity.

Levinsohn[7] put his theory to an experimental test. He obtained a group of monkeys and divided it into two random groups, one of which served as a control group. The other group was put into restraining boxes and placed in a horizontal position with the face down for six hours a day, six days a week. The same type of situation was repeated by Essed and Soewarno[7] and by Marchesani.[8] All three investigators obtained the same general results: between 66 and a 100 per cent of the experimental animals developed myopia within six months after the onset of the experiment while less than a third of the control animals developed myopia during the same period. Since a number of other factors such as increased intraocular pressure, different visual environments and restricted blood supply were operative, it is not possible to say that these results support Levinsohn's theory. It is possible to say, however, that this type of environmental manipulation is capable of inducing myopia: more than capable, very effective.

This experiment points the way to the solution of our problem of the relative influence of heredity and environment in the development of myopia. Monkeys and other types of primates have visual systems which are very similar to the human system. The similarity is so great that much of our present knowledge of the retina and eye is based on the eyes of rhesus monkeys.[14] Further, some species of primates have a much higher proportion of twins than humans. With primate control systems which have recently been developed[9, 20] it is possible to put a monkey into a constant visual environment for at least six months and be able to control every aspect of the physical environment. More than this, the environment can be repeated for any number of monkeys. If it can be shown that the primate twins are one-egg twins, co-twin control studies can be set up in which both heredity and environment will be under almost complete control. By making the environmental conditions as similar to those encountered by humans as possible, the results of such experiments can be generalized to humans.

This approach to the problem of the development of myopia offers greater promise of a successful solution than any extant at the present time. It is only through the use of the experimental method that this problem can be solved.

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THE RELATIVE EFFECT OF HEREDITY AND ENVIRONMENT UPON THE REFRACTIVE ERRORS OF IDENTICAL TWINS, FRATERNAL TWINS AND LIKE-SEX SIBLINGS*

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INTRODUCTION

In recent years there has been much discussion as well as extensive research into the etiology of refractive errors. This matter is not only of academic interest but also of practical clinical and eugenical significance. It has been postulated that refractive changes occurring during an individual's lifetime are the result of hereditary and/or environmental influences. There have been various attempts to separate these factors or to show the relationship existing between them. In a practical manner, such procedures can only be meaningful if we are able to keep one of the factors constant while varying the other. In discussing the hereditary transmission of traits we must remember that the mature germ cell has half the number (24) of chromosomes found in the somatic cells (48) and upon the combination of the egg and sperm in the act of fertilization the diploid number is re-established. Which chromosomes of the total number available that are finally selected for each mature germ cell appears to be a matter of chance.[1] There are 24 pairs of chromosomes in all human cells excepting those set aside for reproduction. Each chromosome is sub-divided into smaller entities called genes. As Osborn[2] states: "Genes are the determiners of heredity. Lodged in every cell in the body, taking part in its growth and function, in constant interaction with one another, these thousands of carriers of all the biological heritage of the past determine the kind of organism that will be produced, the response of each part of the body to different environments, and in the processes of growth, the form of our fingerprints, the cast of our features, and all those subtle differences which set apart one man from another." It is possible that the genes may act by exerting a biochemical action as shown by the work of Crick and Gamow. Hereditary transmission of traits may be further complicated by genes being "dominant," "recessive," having different degrees of "pentrance" or by undergoing a mutation.

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Equally complicated is the setting up of an experimental procedure which would detail the rule of environment alone as being the chief causal factor in ametropia. Such factors as diet, illumination, or amount of near work, are difficult to control. Possibly the best experimental situation that can be set up is that of using co-twin controls. It must be remembered that identical twins are single-ovum (monozygotic) individuals, products of a single conception in which the ovum after being fertilized has split into two identical parts at some stage in the developmental process, each part developing into a separate being, each having absolutely the same genetic inheritance.

Differences which develop after birth, therefore, should be attributed solely to the environment. Fraternal twins are twins which have developed from two separately fertilized ova (dizygotic). Their genetic constitution tends only to be as similar as that of ordinary brothers and sisters (siblings). They may be of either sex while identical twins are always of the same sex. It must be apparent that the members of each twin pair enjoy a common external environment. The same may be said of sibling pairs although here there may be some differences in the environment due to differences in ages. Thus, environment is held relatively constant in this experiment which is designed to compare the similarities or differences of the refractive errors and other optical characteristics between the members of identical twins, fraternal twins and like-sex siblings. If heredity is the predominant causal factor of ametropia we should find a marked correlation between the members of identical twins and lower correlations between fraternal twins and like-sex siblings. If heredity plays a subsidiary role to environment a statistical correlation may not show any significant differences between the members of the three categories.

HISTORICAL

Hofstetter and Rife[3] found a marked correlation of the mean spherical refractive error of 27 pairs of identical twins and a lesser correlation between 12 pairs of fraternal twins. Corneal astigmatism showed no significant correlation among either the identical or fraternal twins. Total astigmatism gave a low positive correlation for the identical twins and approximately zero correlation for the fraternal twins.

In another study Hofstetter[4] studied the variation in ACA ratios in 30 pairs of identical twins and found them to be significantly less than the variations between pairs of families. Waardenburg feels that errors of refraction have a hereditary basis since in a study of about 300 pairs of monozygotic twins and about 225 pairs of dizygotic twins, he finds that for monozygotes 90% show refractive differences of less than 1.00 D. and 74% less than 0.50 D.

Newman, Freeman and Holzinger[3] studied physical and mental differences in 50 pairs of identical twins, 52 pairs of fraternal twins of like sex, and 52 pairs of siblings of like sex. Table I reproduced below gives the results.

TABLE I

Mean pair differences in selected traits

Trait	Identical twins	Fraternal twins	Siblings like-sex
Differences in standing height	1.7 cm.	4.4 cm.	4.5 cm.
Differences in weight	4.1 lb.	10.0 lb.	10.4 lb.
Differences in I.Q. (Binet)	5.9 points	9.9 points	9.8 points

The authors conclude from an analysis of above data that when the factor of heredity was held constant, individual differences diminished.

In another study the same authors studied 49 pairs of identical twins reared apart, and compared their intra pair similarities with the degree of intra pair similarity of identical twins reared together. Table II gives results in terms of the coefficient of correlation (r).

TABLE II

Correlations for three groups of twins

Trait	Identicals reared apart	Identicals reared together*	Like-sex fraternals reared together
Standing height	+0.969	+0.932	+0.645
Weight	+0.886	+0.917	+0.631
I. Q.	+0.670	+0.881	+0.631

*Partial r with age corrected for those reared together. Since the twins reared apart were not all fully adult, they are not strictly comparable.

We are particularly interested in the marked correlation among the identical twins of the physical trait of height since the degree of of ametropia or emmetropa depends on the association of the physical components of the eye, i.e., the relationship which exists between the radii of curvature of the refracting surfaces, the indices of refraction of these surfaces and fluid media and the anterior-posterior diameter of the optical system of the eye. In the study above height appears little affected by the environment. The identical twins reared apart were much more alike in height than fraternal twins reared together and differed little from identicals reared together. From these experiments it appears that heredity plays a major role in the development of physical traits.

EXPERIMENTAL PROCEDURE

Routine refractive procedures were carried out on 10 pairs of identical twins, six pairs of fraternal twins and 10 pairs of like-sex siblings

which were selected at random from the office files. Although the classification system to identify the types of twinning was not as rigorous as that applied by Hofstetter and Rife, it is reasonably certain that with the possible exception of fraternal twins 3A and B, all of the twins were properly classified. With the exception of one set of identical twins and one set of fraternal twins, all examinations were done by the author using the same equipment. External ocular inspection, ophthalmoscopy, keratometry, static retinoscopy and subjective tests were performed on all subjects.

TABLE III

Spherical equivalent refractive error of right eye in diopters for identical twins, fraternal twins, and like-sex siblings.

Subject pairs	Identical twins		Fraternal twins		Like-sex Sibs.	
	A	B	A	B	A	B
1	+0.25	+0.25	—0.12	+0.12	—1.00	—0.50
2	—1.12	—1.00	—2.87	—1.50	+1.37	+1.50
3	+0.12	+0.37	0.00	0.00	+1.50	0.00
4	+0.37	+0.75	—0.50	—1.75	—2.00	—5.37
5	+0.50	+0.37	—0.50	0.00	—0.12	—0.12
6	0.00	0.00	+0.50	0.00	+6.00	—0.12
7	—0.12	0.00			+1.12	—0.25
8	0.00	0.00			—2.25	—9.75
9	+2.25	+2.75			—1.75	—0.12
10	0.00	0.00			—0.75	—2.00

RESULTS

Means, standard deviations of the distribution (S.D.) and coefficients of correlation (r) for all related categories are given in Table IV.

TABLE IV

Statistical data correlating the spherical equivalent refractive error in diopters for the right eye of identical twins, fraternal twins, and like-sex siblings.

	Identical twins		Fraternal twins		Like-sex siblings	
	A	B	A	B	A	B
N	10	10	6	6	10	10
Means	+0.23	+0.35	—0.58	—0.52	+0.21	+1.77
S. D.	0.79	0.90	1.07	0.78	2.26	3.21
r	+0.99		+0.67		+0.54	

The correlation for the identical twins is marked and may be compared with a parent-child resemblance in which the genetic relationship, theoretically, is one-half that found between identical twin pairs. Pearson[6] obtained an r of +0.47 between physical traits of fathers and sons while Wixson[7] obtained a maximum r of +0.45 between the refractive errors of mothers and daughters.

Since it has been postulated that fraternal twins and siblings contain a similar proportion of genes inherited from parental stock, it is

not surprising that their correlations are similar having +0.67 and +0.54 respectively, both substantially below that of the identical twins.

TABLE V

Optometric data obtained from members of a family having different genetic relationships.

Genetic relationship	Type of refractive error	Age	Spherical equivalent right eye (diopters)	Other ocular traits
Identical twin "A"	Comp. hyperopic astig.	6	+2.25	Alt. esotropia
Identical twin "B"	Comp. hyperopic astig.	6	+2.75	Alt. esotropia
Brother	Mixed astig.	13	+0.50	
Sister	Simple myopia	11	—0.50	
Brother	Emmetropia	12	0.00	

Table V shows varying types of ammetropia associated with a set of identical twins and their sibs. The twin members enjoyed a common heredity while the other members of the family had a different genetic relationship to each other. All enjoyed a common external environment although it could be argued that there were some differences due to the disparity of ages. However, this factor is minimized here since reference to the table shows that the three older children are very close in chronological age. The similarities of the ocular characteristics of the twins and the differences between their brothers and sister point to the role of heredity as being the chief factor in determining the refractive error.

TOTAL ASTIGMATISM

For all categories it appears that there is a lesser correlation between the total astigmatic error than between the spherical equivalent refractive error. This would tend to indicate that certain environmental factors play a part in the development in this type of refractive error. The only portion of the ocular refractive apparatus that is exposed directly to external environmental forces is the anterior corneal surface. It may be that this segment of the eye is responsive to differential pressure and temperature changes over some areas of its surface. Indeed, it seems quite clear that the forces exerted by a contact lens does modify the corneal substance—at least temporarily—as witness the familiar spectacle blur and the unaided increase in visual acuity among some myopic patients upon removal of their contact lenses. While it appears possible that environmental influences are effective in the development of the astigmatic error, nevertheless, the basic corneal curves appear to be established by hereditary factors since the identical twins show a marked correlation of +0.93 while the fraternal twins and like-sex siblings show correlations of +0.07 and +0.47 respectively. The following

table gives the results discussed above as well as other statistical data relevant to the matter under discussion.

TABLE VI

	Total astigmatism for right eye. Vertical meridian—horizontal meridian.					
	Identical Twins		Fraternal Twins		Like-Sex Siblings	
	A	B	A	B	A	B
N	10		8		8	
Means	+0.28	+0.25	+0.72	+0.13	+0.44	+0.66
S. D.	0.62	0.40	0.70	0.21	1.18	0.86
r	+0.93		+0.07		+0.47	

SUMMARY AND CONCLUSION

An attempt has been made in this paper to show the relative effects of heredity and environment upon the development of the refractive error. For the sample submitted here and from the evidence of other studies cited elsewhere in this paper, it appears that the closer the genetic ties between individuals, the greater the similarity between both the type and range of refractive error. There is some evidence that environment plays a minor role since the fraternal twins had a somewhat higher correlation than like-sex siblings in which the factor for age was not corrected. While the evidence points to the dominant role of heredity relative to the trait under discussion, such facts must be tempered and weighed carefully because of the limitation of a small sampling. There are only a limited number of twins in any community and any evidence here should be correlated with other studies to form a larger picture.

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RECENT DEVELOPMENTS IN TECHNIQUES FOR MEASURING ASTIGMATISM*

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Although Thomas Young[1] discovered astigmatism in his own eyes more than 150 years ago, it required nearly 100 years before the measurement and correction of astigmatism became a matter of clinical routine. Today, it is generally agreed that the accuracy with which the astigmatic correction can be determined is of paramount importance in refraction since over 80 per cent of spectacle corrections for ametropia now include a correction for astigmatism.[2, 3]

Most tests for astigmatism utilize some form of an astigmatic chart—introduced first in this country by John Green[4] in 1868. Since that time there have been numerous modifications and improvements. The more recent techniques and charts developed by Marquez, Linksz, Crisp and Stine, Lebensohn, Raubitschek, and Pascal make use of the *effects of obliquely crossed cylinders* for the more precise measurement of astigmatism.

The technique of Marquez[5, 6] combines objective and subjective tests. The cylinder indicated by corneal measurements with the ophthalmometer is first placed in the trial frame and the spherical component, determined by retinoscopy, is next inserted in the trial frame. The residual astigmatism is determined by means of an astigmatic chart and a second cylinder correcting this residual astigmatism is also placed in the trial frame. There is then in the trial frame, a sphere and two cylinders usually at different axes which are translated to an equivalent sphere and cylinder by a prepared set of tables.

Marquez claims the advantage of crossing two cylinders obliquely provides a gradual series of intermediate cylindrical values not possible when using single trial cylinders. Linksz and Triller[7] found good agreement between findings by the Marquez method with those determined by the Lancaster-Regan technique.

Linksz[8] also utilizes the effect of obliquely crossed cylinders in a technique which consists of rotating the cylinder in the trial frame

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while the patient is viewing the Lancaster-Regan astigmatic chart and interpreting the results much the same as in the Velano retinoscopy technique developed by Lindner. When the cylinder power is correct, the smallest rotation to one side of the true axis introduces an astigmatic error almost 45 degrees in the opposite direction which is more readily noticed on the astigmatic chart than when letters are used as the test object. When the cylinder power is not correct, small rotations of the axis produces a new astigmatism with axis but slightly different from the original position. The greater the error in power, the less will be the change in the axis of the resultant astigmatism when the axis of the cylinder is rotated. Hence, the behavior of the axis of the resultant astigmatism can be used as a most accurate test for refinement of the cylindrical correction in conjunction with the astigmatic dial.

Lebensohn's[9] "simplified astigmometer" consists of a single-line rotating cross to which has been added an *inverted* 60 degree angle "V" as an arrowhead over one line. The arrowhead is used to indicate the axis. When the eye is properly fogged, the target is rotated until both limbs of the arrowhead match. The cross is then used to determine the power by inserting minus cylinders with axis 90 degrees from the arrow-line.

The Crisp-Stine[10] procedure involves the use of the Jackson cross cylinder and a single-line rotating right-angle target. The target is set to straddle the approximate axis and the trial cylinder is turned toward the axis of the cross cylinder of like sign in the position which renders the dial lines more uniform. The target is also turned a corresponding amount and the test repeated until there is no apparent difference as the cross cylinder is flipped.

The Raubitschek[11] target (Figure 1) consisted of a rotating disc on which two parabolic arcs were arranged so that they were parallel at one end to form (almost) the tip of an arrow and then gradually diverged to form the base. The portions of the lines which formed the tip were at right angles to the lines which formed the base of the so-called arrow. Hence, the two parabolic arcs contained all the 180° meridians.

The unique feature of such an arrow-like figure is the sensitivity at the tip which is such that, even a slight deviation from the true axis is indicated by a jump of the black streak or "shadow" from one side to the other. The great advantage of the test is that the patient has to compare only two lines which are seen simultaneously.

In the original procedure, the axis of the astigmatism was determined by rotating the disc until the "shadow" (blackness) became symmetric on both limbs (or sides) of the arrowhead.

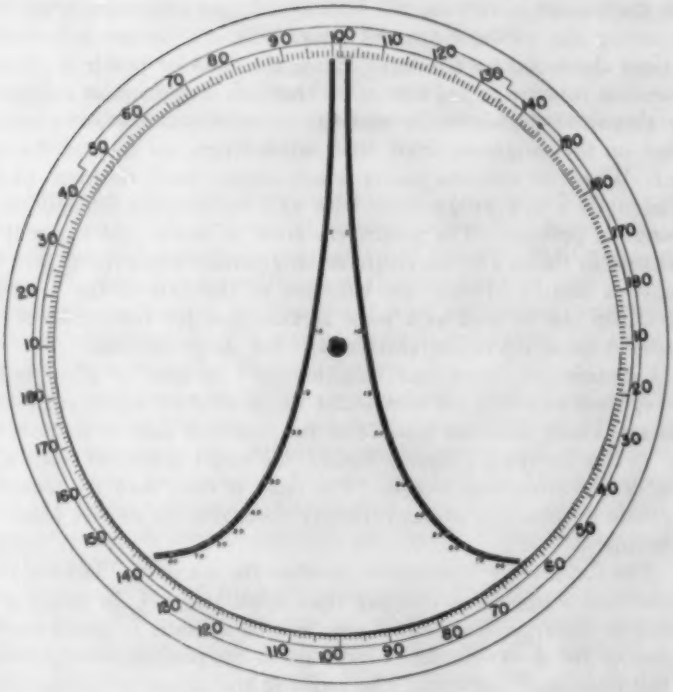

Fig. 1. The Raubitschek target.

The amount of astigmatism was determined by inserting a cylinder of approximately correct power at an approximate axis and rotating the disc again until both limbs of the arrow appeared equally black. It was then necessary to refer to a set of tables based upon the law of obliquely crossed cylinders. Later, Raubitschek[12] added behind the target a second revolving disc which served as a calculator and eliminated the use of tables.

Briefly, the Raubitschek technique consisted of:

1. Determine "true" axis by rotating arrow until "shadow" on each limb becomes equalized.
2. Insert approximate cylinder at 20° from "true" axis in the average case (but at 10° in high astigmatism and at 30° in low astigmatism).
3. Rotate arrow again until "shadows" are once more equalized on each limb.

4. The "true" amount of the astigmatism was determined from a scale on the second revolving disc by following the line corresponding to the power of the approximate cylinder used.

This method required the refractionist to walk the length of the examining room to adjust the charts and read the scale, an awkward and time-consuming procedure which probably forestalled a wider acceptance of this otherwise excellent test.

Pascal[13] introduced the original Raubitschek test in the United States under the name of the Ioskiascopy Test. More recently,[14, 15] he modified the technique by eliminating the tables as well as the second revolving disc. This procedure may be summarized as follows:

1. Determine the "true" axis by rotating the arrow until "shadows" on the limbs appear equal.
2. Select temporary "test" axis of the cylinder 20° off "true" axis, and set the tip of the arrow 35° from original position, towards the "test" axis.
3. Insert minus cylinder power at "test" axis until "shadows" on limbs of arrow appear equal.
4. The cylinder axis is then shifted back 20° to the "true" axis.

Although Pascal's modification eliminated the necessity of reading the correct power from the chart, there was still the disadvantage of the examiner having to remember to insert the correcting cylinder power at axis 20° from the "true" axis; then, to rotate the arrow 35° from the "true" axis position; and, finally to change the cylinder axis 20° from the "test" back to the "true" axis. This indirect method of determining the amount of astigmatism was still fraught with the possibility of error.

Since most refractionists subscribe to the technique of determining the *amount* of astigmatism by equalizing the clearness of two mutually perpendicular lines and, since the principal advantage of the Raubitschek figure is the greater accuracy in determining the *axis*, I have suggested that the parabolic arcs be combined with two dashed perpendicular lines on a new target (Figure 2). In using this target, referred to as the Paraboline Test for Astigmatism, I have found it very sensitive.

The procedure of measuring astigmatism with the Paraboline Test may be summarized as follows:

1. With the eye slightly fogged, determine the *axis* of the minus cylinder by rotating the parabola target until the (blacker) "shadows" of the two limbs near the narrow end of the figure appear equal. (See examples in Figures 3, 4, 5, 6, 7 and 8.)
2. Determine the *power* of the minus cylinder by inserting the

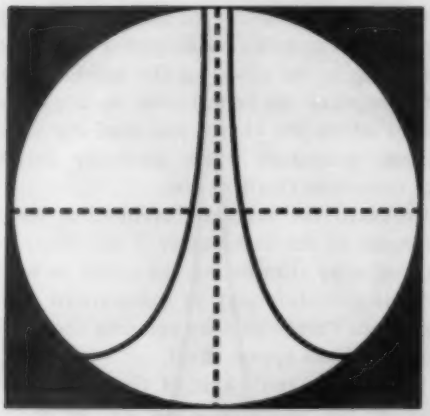

Fig. 2. The Paraboline test target.

cylinder at axis 90° from blacker dashed line (that is, 90° from the axis indicated by the slide pointer) until both dashed lines appear equally black.

A reliable way of insuring that the eye is slightly fogged, that is, that the entire focal interval is just anterior to the retina, is to leave in the trial frame or phoropter a sphere that is 0.50 D. more plus (or less minus) than the net static retinoscopic finding. This can be done

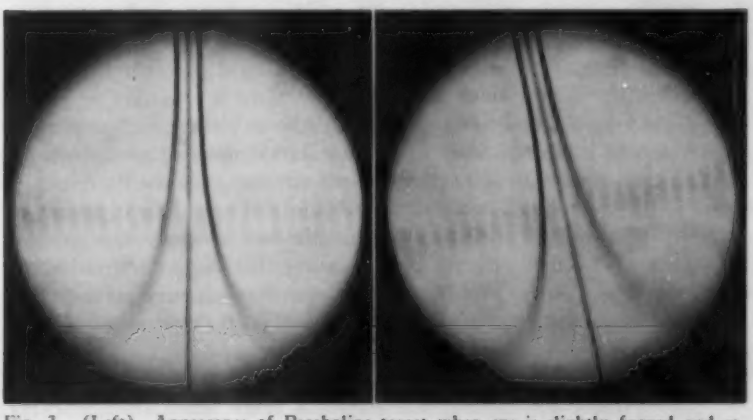

Fig. 3. (Left) Appearance of Paraboline target when eye is slightly fogged and requires minus cyl. ax. 175. Note that when the arrow end of the parabolas is at 90, the right side is blacker.
Fig. 4. (Right) Rotating the narrow end to the left (*away* from the blacker side) to meridian 80 makes the left side blacker, indicating correct position has been passed.

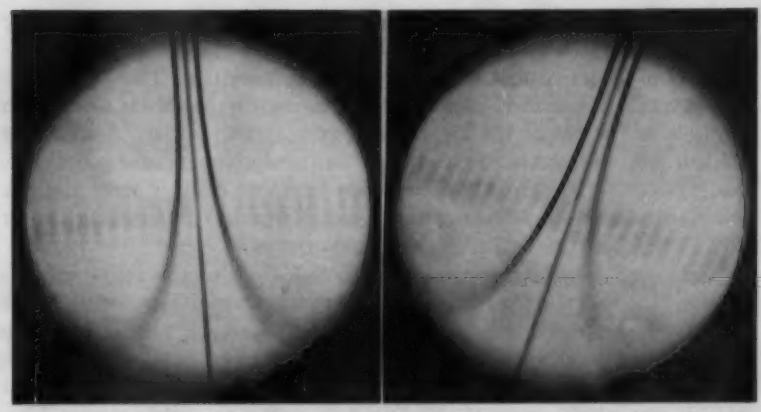

Fig. 5. (Left) Rotating narrow end to the right (*away* from blacker side) to meridian 85 makes both sides equally black, indicating correct position. Minus cyl. ax. 175 is then inserted until perpendicular lines become equally black.
Fig. 6. (Right) Appearance of Paraboline target when eye is slightly fogged and requires minus cyl. ax. 30. Note that when the narrow end of the parabolas is at 110, the left side is blacker.

readily by deducting not the full allowance for the working distance, but 0.50 D. less; for instance, if the working distance is 26 inches (66 cm.) deduct only 1.00 D. instead of 1.50 D.

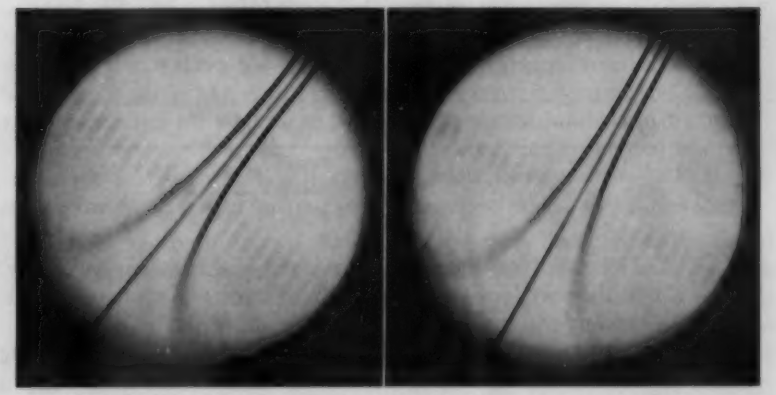

Fig. 7. (Left) Rotating narrow end to the right (*away* from blacker side) makes the right side become blacker than the left at meridian 130, indicating correct position has been passed.
Fig. 8. (Right) Rotating the narrow end to meridian 120 makes both sides equally black, indicating correct position. Minus cyl. ax. 30 is then inserted until perpendicular lines become equally black.

The approximate orientation of the principal meridians having been found by the preceding retinoscopy, the narrow end of the converging parabola is now set in the stronger meridian. The *exact* position of this meridian is obtained by rotating the parabolas until both limbs near the tip of the arrow-like figure appear equally clear to the patient. In this position, the dashed line (which may appear continuous) bisecting the arrowhead will appear more distinct than the one perpendicular to it. Minus cylinder power at axis 90° from the clearer line is then inserted until both lines appear equally clear.

Instead of asking the patient, "Which limb of the arrow appears clearer" the examiner may find the following way of questioning more effective: "Here you see a church steeple. I want you to tell me which side, the right or the left, appears clearer or blacker as I turn it." Or, "Here is a path or road which becomes very narrow at one end. Tell me which side of the road, the right or the left, looks clearer or blacker toward the narrow end of the road."

Or, still another way: "Here are two curved lines or arcs which form what looks like a horn or bugle or funnel; tell me which side looks clearer or blacker near the narrow end."

That the target figure can be described in several ways is actually advantageous, because the examiner can select the one that best suits the patient's perception and vocabulary. Furthermore, the figure with its changing aspects upon rotation has the advantage of being new to most patients. Subjective judgments are sometimes influenced by previous experience, anticipation and familiarity with other astigmatic targets. The surprising change in blackness of each side of the narrow end of the figure stimulates attention, and thus, enables the patient to make critical judgments more easily.

The *advantages* of the new Paraboline Test target for the determination of axis and amount of astigmatism may be summarized as follows:

1. The target figure provides an axis test of the highest sensitivity.
2. In the axis test, only two adjacent lines are compared simultaneously.
3. The amount of astigmatism is obtained *directly* by equalizing two fine, broken perpendicular lines, a criterion which has proved most effective in the measurement of astigmatism.
4. The unique figure formed by the two parabolic arcs may be described as an arrow, a steeple, a path or road, a horn, bugle, funnel, or other similar expressions to suit the patient's needs.
5. The figure with its changing appearance upon rotation is new

to most patients, stimulates attention, and avoids the influence of previous experience.

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ANNOUNCEMENT

SECOND ANNUAL NATIONAL CONFERENCE ON MOTORISTS' VISION AND HIGHWAY SAFETY

The Second Annual American Optometric Association National Conference on Motorists' Vision and Highway Safety will be held October 17-18, 1958, at the Congress Hotel, Chicago. This meeting precedes the National Safety Congress also being held in Chicago October 20-24. Optometrists planning to attend should now make their hotel reservations.

VISUAL PROBLEMS OF THE AGED*

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Since 1940 the number of persons whose age is 65 or more and who are residing in this country has increased by nearly 50% and now totals nearly 14 million individuals. This large group requires special care. There are many problems that arise when dealing with elderly patients. These may be physical, physiological, pathological, psychological, philosophical, sociological and economic, as well as visual. It is the purpose of this paper to discuss the background of the senescent person who presents himself for visual care and the methods of solving some of these problems.

Senescence may be defined as the changes that take place after the cessation of growth, or when proliferation ceases but the powers of regeneration remain. In other words, the building processes are halted and only the maintenance functions remain. When senescence takes place, there are changes in the tissues. Among the fundamental results of injury to tissues are the retrograde changes: i.e., atrophy, degeneration, and necrosis (cell death). These are caused by a wide variety of noxious agents, including trauma, micro-organisms, chemical poisons, radiant energy and nutritional disturbances.

The aged person is usually stooped, the hair is grayed. His senses are dulled as to sight, taste, smell and hearing. He is sometimes irritable and his reaction time is slowed. The skin is thin and wrinkled, making the selection and fitting of spectacle frames more difficult, in order to prevent abrasions.

He is subject to chronic disorders such as arthritis and rheumatism, cardiovascular difficulties, neoplasms, skeletal atrophy, diabetes, palsies, genitourinary disturbances, gastrointestinal upsets and malnutrition. Malnutrition may be caused by a lack of appetite due to impairment of taste and smell receptors, lack of exercise and activity, and a chain is formed which is difficult to break. Ocularly, the globe shrinks due to loss of water, becoming lighter, more spherical, resulting in the tendency toward greater hyperopia.

The eyelids and orbital tissues shrink, the skin becomes thinner,

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less resistent to injury and more difficult to heal. The lachrymal glands produce less tear fluid and the puncta lachrymalis becomes stenosed; thus, although there is less tear fluid, the eye is watery due to insufficient drainage. The lack of tears, causing a burning sensation, is a frequent complaint that is alleviated by the use of artificial tears if the patient will use them. It is, also, responsible for another common complaint, that of a transient, "needle like" pain. This is caused by a few cells of corneal epithelium adhering to the lids, and when the eye blinks, these cells are torn away from the cornea. Ectropion, entropion and trichiasis are frequent complications as are palsy and rheumatism of the external muscles. The latter may lead to scleritis, and usually cause some pain when the eyes move about.

The conjunctiva becomes thinner and wrinkled, and undergoes various degenerations resulting in pinguecula, leukoplakia, fatty and calciferous deposits. Frequently, the palpebral portion is chronically inflamed together with the glands of the lids. There is an increase in mucuous which undiluted by tears, forms an oily film over the cornea.

Changes in the cornea are striking. Here is seen the dull appearance, so characteristic of old age, which is due to the decrease in the refractive index of the epithelium. We see arcus senilis, dystrophies, pigmentation and precipitates on the posterior surface. The cornea is less permeable to salts and water, and is less transparent, and its curvature is more "against" and less "with," the rule.

The anterior chamber is shallower due to increased size of the crystalline lens. The sclera becomes more rigid, thinner, and less opaque. The iris becomes atrophic, sclerosed, hyalinized, more rigid, and the pigment rarified. Its permeability is decreased, which may well be a contribution toward increased intra-ocular pressure. The pupil is small, irregular and sluggish. The muscles of the ciliary body becomes atrophic, and there is considerable infiltration of hyaline.

In the crystalline lens, we have the most significant senile change. The lens increases in thickness, volume and weight, and decreases in transparency. The lamina of the cortex are easily seen with the slit lamp, and the nucleus is well demarcated, taking on a yellowish appearance. Since sclerosis is present, the lens becomes less elastic resulting in presbyopia.

Elderly patients frequently ask, "Doctor, do I have cataracts"? Before we can answer that question, we must consider certain facts. Technically, any opacity of the crystalline lens is a cataract. Few people are free of any lenticular opacities. The author has examined thousands of eyes with the slit lamp and seldom finds one free of some opacity.

Most of these, fortunately, are small, congenital and stationary. Just as neoplasms are differentiated into benign and malignant, cataracts may be divided into "benign" (non-progressive) and "malignant" (progressive). It is with the latter senile type that we are concerned here.

Since the lens is derived from ecoderm, the same embryonic material from which the skin originates, is it not reasonable to expect the lens to change to some extent, as does the skin? The only change that the lens can make is loss of transparency, or change of index. (We are not considering its continued growth throughout life.)

This sclerosis is always present from early adulthood on, becoming more evident with advancing age. If we live long enough, the process is bound to reach the point where vision is seriously impaired. Detachments of the retina and glaucoma may, and frequently do, occur to anyone getting along in years, but cataract is a change due to age, and is inevitable if one lives long enough. Most never reach that age; however, about 15% do, and are affected accordingly. We are not speaking of countries in the torrid zone where cataract is even more prevalent.

Now, returning to the patient's question. "Doctor, do I have cataracts?" My answer depends on the corrected visual acuity. If it is ample for his needs, I say "No, you do not have cataracts," and I explain the analogy of the skin and lens, pointing out that changes have taken place, however. This is a truthful answer, since I do not consider the condition as a cataract unless vision is seriously impaired. This may be an arbitrary attitude on my part but I assure you that it has saved many of these old people needless worry in their few remaining years.

If the visual acuity is poor in both eyes, I tell him that he does have a cataract and advise him to consult a surgeon (ophthalmologist). I encourage him greatly by telling him that after surgery he will very likely have as good vision as he ever had, and that of all the visual afflictions he could have, this is one of the most amenable to relief.

If vision in one eye is adequate, I do not recommend surgery, since the whole problem is complicated by monocular aphakia. Usually the diminution of vision in the one cataractous eye is so gradual that the patient is able to compensate for the loss without undue difficulty, and does not notice the lack of binocularity. He is contented with the one good eye. By these criteria, he may never live long enough to require surgery, and thus be spared such an ordeal.

One may say "all this sounds good, but what if a patient, who is now operable, becomes debilitated and is unable to stand such a procedure later?" It has been shown that with modern means, surgery

may be undertaken in almost anybody, even those with marked physical disability, with a high degree of assurance of success.

One of the most treacherous anomalies that occurs frequently with age, is primary glaucoma. The probability of an attack is 3,000 times as great in the seventh decade, as in the first. 90% of primary glaucoma is found after the 40th year. 12% of all adult blindness is caused by this malady, so we must be most alert for its presence, especially in elderly patients.

The vitreous usually has a number of opacities which is one of the basic causes of the "spots" of which older patients complain. Unfortunately, however annoying these may be, the patient must learn to live with them. Synchesis is common. The retina is frequently affected by senescence. It loses its youthful luster, and tends to be affected by cysts, pigmentary degenerations, detachments, atrophy, hemorrhages, macular holes, and by many other conditions which cannot be alleviated medically. Dark adaptation has a higher threshold and takes longer, and color discrimination is poorer.

Fisher found the following senile changes in almost all of 44,000 eyes, upon pathological examination:

1. Arcus senilis.
2. Depigmentation of iris, stroma, and pigmented layer of the iris.
3. Precipitates on posterior surface of cornea.
4. Turbidity of the lens.

We may consider these as normal senescent changes which seem to occur almost universally.

Whether senile changes are physiological or pathological, is a moot question. Frequently, many of these changes are found in young people who suffer with some chronic illness, so it is possible that senescence itself may, some day, be considered a disease. Thus far, however, we are not justified in making such claims for it. This, briefly, describes some of the ocular and visual changes that have taken place. By no means are they all included.

* * * * * *

"Old" in our culture, is an epithet, old age is too often an affliction, a penalty for survival, a yoke attached by the young and immature. In our culture, age in the market place of ideas and usefulness is rated at a 100% mark down. Old should be an honor, and old age a reward and should receive for its contribution, recognition, and be accorded at least the courtesy of equal opportunity. Old people have been made second class citizens by shunting them aside in industry,

in the family, and in the community. Society has been only too successful in making the aged feel pessimistic, lonely, unwanted, and perhaps worst of all, bored. All this to a person who has already weathered many of the vicissitudes of life, who has made his contribution, and can now look forward to little else, in our society, but termination. The drive for self preservation begins to assert itself anew with age, and the old person becomes more aware of self and less concerned with others. He begins to perceive and often to fear, that he is aging. It is difficult for him not to resent the fact that change is inevitable. Silently, he tries to determine how many more years of his life span are left.

Often the first indication of senescence occurs around the age of fifty. Fatigue is the initial and most frequent complaint. Next there is an inability to function as efficiently or as rapidly as before. It takes an older person longer to recuperate than it did when he was younger. The biological factors seem to precede the psychological. In men, there is a gradual decrease in strength, skill, endurance, and sexual prowess or potency. In women, the first concern, following a sense of fatigue, is an awareness of gradual loss of physical attractiveness and concern about being no longer able to bear children.

With such feelings of frustration, visceral tensions and dysfunctions appear. Constipation, pyloric and intestinal spasms, flatulance and complaints of indigestion arise. External stimuli lose their zest and novelty. A cynical attitude develops toward the anticipations that formerly caused pleasure.

As age advances and there is increasing difficulty in remembering names and recent events, some consolation may result from a feeling of justification in recalling there are more names and events to remember. But the senescent person gradually avoids adding to the accumulations of his knowledge. As the duration of his earthly existence shortens, he seeks compensation by retreating to his prolonged past and reminiscing.

Brief reference should be made to the organic mental illnesses that eventually ensue for all human beings if they live long enough. Although the senile psychoses seem to be decreasing, the psychosis associated with cerebral arteriosclerosis is increasing so markedly that the phychosis of old age, as a whole, is showing a definite rise and is becoming one of the leading problems in psychiatry. Although the etiology of cerebral arteriosclerosis is still obscure, heredity and the tensions arising from environmental stress are influential. It is important to study these aging patients as persons who break down because

of two sets of factors—personality problems, and degenerations of brain tissues. In general, the greater the functional elements present, the better the prognosis. Many, however, are more alert than might appear on superficial observation, and are aware that they are inadequate, and preserve some degree of intellectual integrity.

Added to the physical changes which normally occur as part of the aging process, we have, also, the insults and injuries suffered by the body throughout the years of living. These may result in an acceleration of the aging process, so that we find abnormally early signs of decreased efficiency in the functioning of the organism, or in an increased susceptibility to the chronic disabling physical conditions so frequently found in later life. These constitute a very special and real stress to those in the older age groups and, undoubtly, this stress is aggravated by unhealthy emotional reactions.

In the final analysis, it is evident that while physical changes do occur and constitute a real threat to older people, it is how these changes are accepted that is the important thing. Physical changes, whether normal or abnormal, are not the only source of stress arising from within the individual. Changes in intellectual functioning, also, occur as part of the normal aging process. Normally, people do not grow stupid as they grow older, but they do show changes in their ability to make efficient use of their native intellect. They tend to slow in speed of thinking, acting, and learning. They can and do learn new things, but learning is slower and requires greater effort. They are likely to remember the things and events of bygone days but to forget the new, to become less flexible and adaptable, and to show less desire to learn new things. Thus, we find some older people who refuse to attempt to learn anything new on the theory "that you can't teach an old dog new tricks."

By developing psychic rigidity, the decrease in the efficiency of ego-organization makes adjustments and re-adjustments to life more difficult so that many older people tend to cling to the old and well known, rather than attempt the new and untried.

Stresses are incurred with the decline and efficient functioning of the sensory mechanisms, particularly those of vision and hearing, and many experience mounting tension when they find they cannot see or hear as well as formerly. To some, the wearing of spectacles or a hearing aid is a traumatic experience since it is felt that it presages the onset of old age. All these stresses, whether from the aging process itself, from social or economic discord, from loss of contemporaries and consequent loneliness, from change in family status, or from the fear of approaching

death—is enough to cause emotional upset in an individual. When we consider then, that the majority of persons are subject to most, if not all, of these stresses in later life, we can readily see there is a real need for special study to help these patients cope with these problems.

This, then, is the background of the elderly patient who presents himself to the optometrist for visual care. This patient, we must keep in mind, has many or all of the stresses that have just been mentioned. All these in addition to the problems of vision that everybody else is subject to. How are we, as optometrists, going to supply the greatest possible aid to these people? That is the question I hope to answer now.

Usually, the elderly person comes into the office with some member of the family. My secretary fills out a record form with the full name, address, etc., and the patient is ushered into the examination room alone. This is done with all patients, since a third person in the room changes the relationship or rapport between the doctor and the patient, and the patient is aware of an audience and feels the necessity of playing to that audience. An even more important consideration is that the old person likes to maintain a certain degree of independence and resents being treated like a child, which is the way his family does treat him, in most cases. Many times it is the only way they can be treated because they do act like children but, unfortunately, they retain a great deal of the authority of the adult. When alone, this patient is much more tractable and at ease, and will reveal to the optometrist a great many things about himself that he would not tell his family, even if his life depended on it.

We secure as complete a case history and list of complaints as can be gotten from the patient, and then go into the waiting room, and in a low voice, so that the patient cannot hear, ask the family member for the history and complaints all over again. It is at times surprising how much the two versions will differ. Old folks are forgetful and might omit some very pertinent fact such as the existence of diabetes, or that an eye has been poor since childhood, or what ocular advice has been given, previous spectacles and by whom, etc. The family is greatly helpful in these instances.

The objective examination is frequently difficult (except for the keratometer) because of small pupils, and opacities or irregularities of the media, so we are quite dependent on the subjective examination. This latter is quite difficult, also, because of lack of judgment and the unreliability of the answers. These people, if they like you at all, will try harder to please you than to help themselves. I once had one confide in me, after having consulted a very competent man without

satisfactory results. She tried so hard to please that nice little fellow, but she couldn't see with his spectacles and didn't want to go back because it might hurt his feelings.

The patient at all times must be treated as an adult, gently but firmly, and with the greatest of diplomacy, patience and courtesy. There must be no doubt to him that you are sympathetic to his troubles, but you as the doctor, are in charge of the proceedings. At best, these old people are nervous and easily confused and the least sign of exasperation on the part of the examiner, regardless of the provocation, will be instantly communicated to the patient, accompanied by his complete loss of faith and confidence. If that happens, no matter what the visual results are, the patient will remain dissatisfied and will consult someone else at his earliest opportunity.

We work as quickly as possible to avoid fatiguing the patient but always act as if we had all day for this examination. We give plenty of time for answers, and always try to act in an encouraging and confident manner, and stop for occasional rest periods, during which it is relaxing and gratifying to the patient to talk about the "good old days." Allowing the patient to tell his stories about the past makes him feel closer to the optometrist, and will build up his confidence. We do not let him go on endlessly, however. This confidence will do as much for him as a new correction. If possible, we reassure him that he is not going blind, if he asks. We diligently strive to bring out the best possible vision with any and all means at our command, and do not hesitate to use unorthodox methods if they give results where everything else has failed. We try high cylinders and spheres and in combinations and use strong adds for near. An add of +6.00 D. or +8.00 D. is by no means unusual to help enable these people to read. Also, additional lighting may help. However, even though in our refracting room, we have found the means to improve vision, it does not imply that such aids will be used.

The point has now been reached that requires great skill and judgment. We know what ophthalmic aids will give best visual acuity, but is it feasible to prescribe them?

Let us consider the needs and wants of the patient, his mental and physical conditions. What is his environment with regard to posture, illumination, etc.? If he has palsy or is "weak and trembly," it is manifestly impossible to use a device that has a short depth of focus, and must be held close. If his mind wanders and he cannot retain what he reads longer than it takes to read it, there is no need of critical near seeing. These are only a few of the possibilities that may occur.

A cardinal rule to remember is that old people are opposed to any change whatsoever in their daily pattern, so we advise or prescribe the barest possible minimum. Whatever habits these patients have, whether visual or otherwise, they are going to keep, or if changes are absolutely necessary, they will be slow in coming about. If the prescription does not conform to the accustomed pattern, the prescription will be discarded rather than a habit change.

Of course, the use of strong adds brings up the problem of intermediate distance, and I am happy to say that unless the patient is physically handicapped, trifocals may be used almost exclusively. The patient is not told what is going to be prescribed, and nothing more is said about it. He is merely shown how to use the prescription.

Many elderly people spend a great deal of time reading the Bible, and frequently the print is small, making it quite difficult to see. It is well to insist that a Bible with larger print be used so that it may be read with greater ease. True it will result in a larger and heavier book, but it is evident that visually it is a boon, and the patient will be able to read longer with less discomfort.

If vision could be restored, many elderly people could become self-supporting and change from an economic liability to an asset. Likewise, many who are forced to live with family, thus provoking discord and making everybody concerned unhappy, could become independent and relieve the tensions in themselves and their families. Would this not be quite an accomplishment?

SUMMARY AND CONCLUSIONS

The increasing number of elderly people has added, to the optometrist, the responsibility of caring for these patients. Greater understanding of the physical, physiological, psychological, economic, etc., background of these patients, as well as improved visual care, is necessary.

Actual clinical handling of the patient is described with emphasis on the fact that we are dealing with a human being and not just a pair of eyes.

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VISUAL SCREENING IN A COUNTY SCHOOL FOR DELINQUENT BOYS*

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Eighty young males confined in a Home School for Boys were visually screened by the authors. Their ages ranged from nine to 18 with a mean of 14.8. Achievement quotients (A.Q.) and intelligence quotients (I.Q.) were available from the official records of the school. The I.Q. scores had been obtained with the Wexler-Belvue test. The A.Q. scores, either with the California achievement test or as a product of the I.Q. (A.Q. = E.Q./I.Q. × 100, in which E.Q. stands for educational quotient.)

The screening procedure was as follows: The greater part of the Keystone visual skills battery was administered by means of a telebinocular. DB10 A, dog and pig for simultaneous perception; DB 9, arrow and numbers for lateral balance; DB 8C for vertical imbalance; DB 4 K, four balls for fusion at 6 meters; DB 3B and 2B for visual discrimination at 6 meters; DB 9 for lateral balance at the near-point; and using the same card as for distance and DB 5K four ball card for fusion at near. For stereopsis, card DB 6D was used. In this latter case, when response was poor, the "stero-fly" was used with polaroid lenses. All of the above tests were administered by one of the authors while the other performed the external ocular inspection of the eyes, the ophthalmoscopy and the retinoscopy. No more than two students and two examiners were in the examination room at the same time.

In scoring it was felt that a single score for distance fusion was desirable and that the four ball test was more indicative of the quality of fusion than the arrow and numbers. Here the inability to see three dots constituted a failure, while four dots fused into three after an interval was considered borderline. Only three dots, seen immediately, rated a "pass." The same type of scoring applied to the findings in using the DB 5K card at the near point.

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All students having visual discrimination of signboard eight or better with each eye separately passed the acuity test. Those unable to do so with either eye failed.

Students with ability to distinguish nearness of symbols in line nine through line 12 rated a pass in stereopsis. Those students unable to reach line nine or having a positive response to the stereo-fly were regarded as borderline and all others failed this part of the test.

Retinoscopy was performed with the aid of a rack containing pairs of +1.00 D. spheres; +2.00 D. spheres and +3.00 D. spheres. Retinoscopic neutrality through the +2.00 D. spheres with a working distance of 20 inches constituted a theoretical emmetropia. A working allowance of one-half diopter was made and findings over this constituted failure.

Results in the external ocular inspection and the ophthalmoscopic examination were noted on the charts but not scored in the final tabulation. In the final report to the authorities only those students who failed in the acuity tests and retinoscopy were advised to have further refractive care. The poor fusion cases were placed in a separate group who required orthoptics, which was not available. The raw data follows:

Achievement Quotient.	Retinoscopy Students Pass	Retinoscopy Students Fail	Visual Acuity Students Pass	Visual Acuity Students Fail	Students Using Spectacles Yes	Students Using Spectacles No
—90	22	9	23	8	4	27
90-110	29	19	35	13	8	40
110+	0	1	0	1	0	1
Intelligence Quotient.						
70-90	14	5	15	4	1	18
90-110	33	20	39	14	10	43
110+	4	4	4	4	1	7

(P) Pass. (B) Borderline. (F) Fail.

Achievement Quotient.	Fusion at Far. Students (P)	Fusion at Far. Students (B)	Fusion at Far. Students (F)	Fusion at Near. Students (P)	Fusion at Near. Students (B)	Fusion at Near. Students (F)	Stereopsis. Students (P)	Stereopsis. Students (B)	Stereopsis. Students (F)
—90	24	2	5	21	3	7	27	3	1
90-110	35	5	8	28	7	13	42	5	1
110+	1	0	0	1	0	0	1	0	0
Intelligence Quotient.									
70-90	14	1	4	15	2	2	15	3	1
90-110	41	4	8	31	6	16	48	5	0
110+	5	2	1	4	2	2	7	0	1

Achievement Quotient.	Intelligence Quotient 70-90 Students	90-110 Students	110+ Students
—90	12	16	3
90-110	7	37	4
110+	0	0	1

Intelligence Quotient.	Achievement Quotient —90 Students	90-110 Students	110+ Students
70-90	12	7	0
90-110	16	37	0
110+	3	4	1

CONCLUSIONS

Because of the small sample and manner of scoring, a coefficient of correlation was not derived. However, it does not take much study of the tables to find a lack of correlation between the A.Q. and the I.Q. on the one hand and the visual findings on the other. Before jumping to hasty and negative conclusions, the following must be considered: All subjects in this study share a similar milieu and are, for one reason or another, at odds with the accepted standards of society. It would be necessary to compare the findings with similar ones taken on subjects under different circumstances before drawing any conclusions. A recent study by Jorgensen* (U. of Minn. 1957) dealt with the visual skills of a group of exceptional children (high I.Q.) Since testing conditions and standards differed from the present study, the results can not be correlated. Curran (OPTOMETRIC WEEKLY, Nov. 14, 1957) quotes John Warren Hill, presiding judge of the New York Domestic Relations Court, as follows: "Training in remedial reading has proved an effective measure for the correction of many behavior difficulties. Reading retardation seems to be a contributing cause of, or concommitant to the disturbance of many children which leads to juvenile delinquency." Curran continues: "These children usually pass the screening test because they have not read enough to force visual adaptation or to make their visual difficulty manifest. Therefore only a complete visual case study will locate the visual condition and aid in identifying the child whose only complaint is inability to achieve through the printed page. These findings must be interpreted as part of the complete pattern for the child's stage of development must also be considered."

This may well be part of the explanation for the lack of correlation in this study. Nevertheless in the few cases which had failed the screening *and* were seen by one of the authors in private practice

*Masters Thesis. University of Minnesota Library.

(visual care is not routinely provided by the school and is the parents' responsibility) the subsequent visual analysis fully bore out the earlier findings.

The authors gratefully acknowledge the assistance and advice of Mr. Edward Sedio, superintendent, and his staff at the Hennepin County Home for boys, without whose help this study would not have been possible.

905 PROFESSIONAL BUILDING
HOPKINS, MINNESOTA

ANNOUNCEMENT

TWELVE SCHOLARSHIPS AVAILABLE AT HOUSTON

Applications are being accepted for twelve scholarships of $500 each, totaling $6,000, which will be awarded to students from eleven states in the South and Southwest who plan to enroll in the College of Optometry at the University of Houston. The optometric scholarships are for students entering their first year in the College of Optometry in the 1958-59 school year.

These scholarships are a part of the Better Vision Program instituted by the University of Houston to meet growing demands for professionally trained optometrists in the South and Southwest. The University of Houston is one of two schools in this area that offers degrees in optometry. The eleven states participating in the Better Vision Program include Alabama, Arkansas, Florida, Georgia, Kansas, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma and Texas.

Optometrists, optometric laboratories and suppliers, and ophthalmic manufacturers throughout these states have provided the Better Vision Scholarships to be awarded to at least one applicant from each participating state, plus one scholarship designated for a woman student.

Qualifications necessary for admission to the College of Optometry are completion of two years general college, including one year's work in chemistry, physics and zoology. Applications should be sent to the dean, College of Optometry, University of Houston, Houston 4, Texas.

Other scholarships available to students in optometry are four scholarships of $200 each sponsored by the Foundation for Education and Research in Vision of Austin, Texas.

NOTES ON FITTING CONTACT MICROLENSES*

Penrhyn F. Thomas† and O. Ashley Williams‡
Sydney, Australia

The fitting of a cornea with a microlens made with an inner curve of more than one radius of curvature is by no means new in its concept, however the ratio of the curves varies in different designs. The recent multiband lens developed in this practice which is based upon a fluid lens of —0.50 diopters has yielded results superior to previous designs used by the writers.

In order to evaluate the performance of the new design, a project was conducted to obtain tolerance figures for this lens. It is the purpose of this paper to bring to optometrists these results, together with observations made on the project.

THE SAMPLE

The patients for this project were selected entirely at random and constitute an unbiased cross section of the authors' practice. The sample is a cross section of refractive error, physical fit, and psychological fit. It should, however, be understood that as this is a purely specialist practice; the type of patient seen differs in initial attitude to that seen by a general practitioner who specialises. In most cases the underlying difference is based upon the fact that a patient enters the specialist's waiting room for the express purpose of being fitted with microlenses. The attitude must differ from the patient who is being converted to their use by their own practitioner. To a large extent the specialist has the advantage of handling referred patients. With respect to patient selection, every patient who is prepared to pay the fee is fitted (obvious physical defects being rejected). No patient is considered unsuitable until they have worn a pair of lenses for at least two months. The sample has included patients in this category.

TOLERANCE

For the purposes of the project, tolerance is defined as a fit which is described by the patient as being comfortable and not requiring any conscious effort to keep the lenses in the eye.

All day wear has been considered as any time in excess of 12 hours. It includes the patient's waking hours and varies from day

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to day. One case reported a wearing time of 25 hours without removal. The patient remained awake for this period. The tolerance times used were limited to the definition above, although some cases could increase their wearing time by conscious effort.

THE LENS

The multiband design used in the project was fitted with a central radius of curvature 0.50 diopters flatter than the flatter meridian of the central portion of the cornea. A combination of two limbal bands in fixed ratio to the base and to one another was used in each case. The diameter of the lens in all cases was 10 mm. White lenses were used and both eyes were fitted with the same cornea-lens relationship. All the lenses had the same edge thickness and contour. The vertical corneal diameters fitted varied from 11 mm. to 12 mm. and the apertures varied from average to wide. The eyeball classification was average in all cases. Few adjustments of any nature were carried out (on the lenses) during the eight weeks period, but variations were made in wearing times.

WEARING TIMES

Each case was put on the same wearing schedule, all day wear being the aim at the end of an eight weeks period. Cases which have reached all day wear after this period have been noted and the figures for all day wear would be more favorable if the build up period had not been limited.

RESULTS

The most important result is the figure for all day wear at the end of eight weeks. This was found to be 81.5%. The full figures are:

Number of cases	65
All day wear within four weeks	29.0%
All day wear within eight weeks	81.5%
Eight hours per day within eight weeks	90.7%
Six hours per day within eight weeks	96.9%

OBSERVATIONS

The confidence of the practitioner in microlenses and his ability to fit them plays a basic part in building the essential confidence in his patient. Each patient was directed to carry out a certain wearing schedule with the inuendo that failure to keep to it is their own fault and may lead to their inability to wear the lenses. It was, of course, strongly inferred that failure is quite rare. These factors are, of course, part of the psychological fit, and attention to this aspect is of importance.

Further, with regard to the physical fit, alterations were made to the fittings of those cases which did not reach all day wear in

the period, and that limbal band adjustments were used to keep the fitting equivalent in all diameters. Adjustments to edge contour were also made on those cases not wearing all day at the end of the period.

REFERENCE

Recent Tolerance figures for Thomas Multiband Micro Lenses. Williams, O. Ashley. Australian Journal of Optometry, January 31, 1958.

THIRD FLOOR, STATE BUILDING
49 MARKET STREET
SYDNEY, AUSTRALIA.

ANNOUNCEMENT

INTERNATIONAL LIGHTING VOCABULARY

A new international vocabulary of lighting terms, the culmination of 20 years of study by a working party of the Commission Internationale del'Eclairage (C.I.E.), is now ready for distribution through the organization's United States National Committee.

Printed in three languages—French, English, and German—the vocabulary was created for the purpose of facilitating communication between scientists the world over who are working in the field of illumination.

The publication, entitled *"International Lighting Vocabulary of the International Commission on Illumination, Volume I (2nd Edition),"* contains 530 terms, with definitions, as well as numerous symbols and formulae. Its principal sections cover Radiation, Photometry, Colorimetry, Eye and Vision, Production of Light, Lamps, Auxiliary Apparatus, Lighting Techniques, Lighting Fittings, and Light Signals.

The United States National Committee has placed a prepublication order for the first volume and is offering it at a reduced price. A limited number of copies are now available at $2.50. It is expected that the price will be raised when the initial supply is exhausted. Orders for the publication with remittances payable to "U. S. National Committee, C.I.E.," should be sent to T. D. Wakefield, Treasurer, U.S.N.C., Vermilion, Ohio.

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HEREDITY AND ENVIRONMENT

In the present issue two papers deal with the same problem but were written by authors widely separated geographically and trained in different disciplines. These papers are of special interest since the conclusions which may be drawn from each study are almost directly opposite from the other. Francis A. Young, professor of psychology at the State College of Washington, and Richard J. Wixson, practicing optometrist in Shamokin, Pennsylvania, both Fellows in the American Academy of Optometry, have each set out to assess the relative importance of heredity (nature) and environment (nurture) in the genesis of refractive errors. Both authors have used the same technic, namely, correlation between pairs bearing some blood relationship to each other.

The assumptions are well stated by Professor Young:

> Those measures which are primarily hereditarily determined will show higher correlations than those not so related when pairs ranging from no relation to identical twins are taken from a comparable environment. Thus we find the highest correlations between physical measures such as height, +0.93, weight, +0.92, and head

width, +0.89 with identical twins; lower correlations, e.g. height, +0.65, weight, +0.63, and head width, +0.55, with fraternal twins and still lower values for siblings. . . . Pearson has suggested that a correlation of +0.52 obtained with an unselected environment indicates a purely hereditary determination.

Wixson found correlations for refractive state as follows:

10 pairs of identical twins	+0.99
6 pairs of fraternal twins	+0.67
10 pairs of like-sex siblings	+0.54

The very close agreement between the findings of Wixson and the criteria for a purely hereditary determination set up by Young is worthy of note. However, the small sample size will make one cautious in interpreting these findings. It may further be noted that the fact that these findings are in an orderly sequence increases their significance. While each coefficient by itself may lack statistical significance, the probability that all three coefficients would by chance alone so closely approximate the expecteds is markedly less than that for any one coefficient. Further, as Wixson points out, these findings are compatible with earlier findings of Hofstetter and Rife on 27 pairs of identical twins who showed a higher correlation coefficient than did 12 pairs of fraternal twins. These authors used a graphical method of analysis and did not calculate coefficients, nor did they present the raw data from which these might be calculated. Thus, while their study tends to confirm Wixson's findings, the degree of conformity is at the moment not known.

Young studied the same problem from a slightly different angle. He did not study twins but did study 207 pairs of siblings. He found correlation coefficients for male sibs, female sibs, like-sex sibs, mixed sex sibs, and for the total. To demonstrate hereditary transmission of refractive state one would expect coefficients of the order of magnitude of +0.50. None of those found by Young approximate this value and they, in fact, much more nearly approximate the zero value which would indicate environmental differences as the sole determinant of refraction.

Reconciling the two sets of findings is difficult. Young's sample is adequate in size, so this cannot be involved. Young used first order partial correlation coefficients to statistically remove the effect of age. It should be noted that since there is a correlation between age and refraction, this factor of age should be partialled out. In sibling studies the members of the pair are of different ages, and partialling out age will tend to increase the coefficient, a phenomenon which does occur in Young's study. On the other hand, in twin studies where the two members of the pair are of the same age, the partial coefficient will be lower than the zero order coefficient. Wixson did not partial out the

effect of age, and this may account in part at least for the magnitude of his findings. Also worthy of note is the assumption of Young that partialling out age also takes care of sex differences, an assumption which may not be completely valid.

One other difficulty in all pair studies, whether twins or siblings, is the question of which of the pair is to be considered an X value and which a Y value. It was to overcome this problem that Hofstetter decided to plot each pair twice, once with one member as an X value and once with the same member as a Y value. This, however, necessitates using a graphical presentation and does not lend itself to Pearsonian correlation methods and comparison with other variables investigated in this manner.

Another approach to the problem of assessing the relative contribution of hereditary and environment has in the very recent past been applied to another biological problem, that of serum lipids. Osborne and Adlersberg* have reported on the serum lipids in 82 pairs of adult twins both identical (monozygotic) and fraternal (dizygotic), some of whom were living together and some of whom were living apart. The greatest similarity was found for identical twins living together, the least for fraternal twins living apart, with identical twins living apart and fraternal twins living together falling between these two extremes. This enabled these authors to conclude that both environment and heredity play a part in determining the serum lipid level.

Considering these three types of study as they apply to the problem of refraction with the idea in mind of setting up another and perhaps more nearly definitive study, certain facts are apparent. Finding a sufficient number of pairs of adult twins who were reared apart is almost an impossible task. However, optometrists in practice should be aware of the value of such patients to research. If such a pair should be seen by an optometrist, the complete optometric findings of each member of the pair, a description of the sociological phenomenon which led to the twins being reared apart, and a statement of the possible differences in visual environment of each member should be published. While each such report would be of limited value, over a number of years a sufficient number of studies on twin patients should be in the literature to enable a review on all such patients.

Sibling studies also offer a number of difficulties, the statistical handling of age and sex being the greatest. Were another such study contemplated, it would seem advisable to consider siblings of like sex

*Osborne, Richard H. and David Adlersberg. Serum lipids in adult twins. Science: 127 (3309) 1294, May 30, 1958.

only and of nearly similar ages (a year or two apart) or of an age when refraction is stable. Even this latter course is not completely free from difficulty, for some anomalies are found mainly among children born to aging parents. While it may be argued that such anomalies are congenital, their existence nonetheless complicates the problem.

A twin study in which fraternal and identical twins are compared and in which the effect of age is partialled out seems to hold immediate promise if a sufficiently large sample can be obtained. Wixson has obtained data on sixteen pairs of twins in his own practice. Based solely on our memory, we were able to find records on nine pairs of twins in our own office files. Clearly, if thirty or forty optometrists would draw all records of twins which they can call to memory and submit them to one place for analysis, such a project is immediately feasible. The present author proposes to set up such a project. Readers of this JOURNAL are urged to submit as many twin records as possible from their office records. These will be analyzed, and a paper reporting the results will be forthcoming in this JOURNAL in the near future.

In submitting data, optometrists are urged to include the following information:

(A) Age of twins at the time the visual examination was performed.

(B) A statement as to whether the twins are identical or fraternal and the basis for classification. This should be a physician's statement, serological tests, parent's statement, or other evidence. It is suggested that the optometrist's observation of degree of similarity be included regardless of other evidence.

(C) Name, sex, and refraction of each member of the pair. It is suggested that the exact refraction be stated in the usual form of sphere, cylinder and axis. In order of preference, subjective to best acuity should be first, then static retinoscopy, then any other method. State the method used. The given name will aid in randomizing the data since the name which is alphabetically first can always be the X value, and the other the Y value. The family name will also be of help in avoiding duplication of records in the event of the patients' having moved and transferred to another doctor.

Data for this study should be submitted to "Twin Study," Post Office Box 649, Ojai, California, or in care of the author at that address.

MONROE J. HIRSCH

SPECIAL REPORTS

VISUAL DISTURBANCES OF A DIABETIC*

John R. Reynolds†
Topeka, Kansas.

The writer would like to present the following case of a diabetic patient, primarily for the purpose of helping optometrists who may be confronted with a similar case. This report is not being presented as the correct procedure for handling a diabetic case, but simply to show the many pitfalls one may encounter when serving such a patient.

First, the writer has been a diabetic since 1951 and because of this my family has lived pretty much as a diabetic lives. In other words, they have eaten plenty of wholesome food but, few sweets and few heavy starches in our diet.

Being a diabetic, the writer has kept close tab on his sons, giving them the clinitest urinalysis check every three or four weeks. They had never once shown a positive finding. A blood sugar test was run in September of 1957 with the finding negative.

My oldest son, David, is fourteen years old. As all teen-agers, he is growing like a weed and eating and drinking water all of the time. This, as you know, is typical of a teen-ager. Therefore, I thought nothing peculiar when he was always hungry. However, on December 13, 1957, he said he was just worn out and was coming home after school and going to bed. For him this was unusual, so I ran a urinalysis. It showed a high 4+ count, which is a high sugar content. I called our physician, gave him the symptoms, and fortunately he told me to bring the boy directly to the hospital.

Upon arrival, several tests were run. They started feeding him intravenously, as he had become dehydrated. His blood sugar reading was a high 546, urinalysis 4+, and the test for acidesis read 17. He was a mighty sick boy. Of course, they started giving him insulin immediately; and under very close supervision for 24 hours they had his blood sugar down and much of the infection cleared. We were very fortunate to have had a physician who knew exactly what to do.

As we look back now, we can see symptoms he had shown in the last three weeks. He drank a lot; his legs were tired and hurt; he told

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†Optometrist.

us he had lost 15 to 18 pounds in two months; his breath had been very bad, which was unusual; and he was just tired. However, look at the symptoms and you will just see a lot of average teen-agers.

He was in the hospital six days and then back in school and doing fine. We have him pretty well balanced on diet, insulin, exercise, and rest.

The following is a summary of four refractions made on this patient. September 1, 1957, O. U. —0.50 D. sph. December 21, 1957, O. U. +2.25 D. sph. December 28, 1957, O. U. +0.75 D. sph., and January 5, 1958, O. U. —0.50 D. sph. During the acute stage of his illness his esophoria increased from 1Δ to 6Δ. After his refraction of September 1, 1957, the writer prescribed O. U. —0.50 D. sph. for distance work in school only, with a +2.00 D. sph. added for reading in bifocal form. He used his spectacles only in school and in reading. On the examination and refraction of December 21, the patient reported that at 6 m. the vision was better with both eyes than with each eye separate, but at near the vision was better with each eye separate than with both eyes together. The patient's blood sugar on January 5 was running 120 and the urinalysis was 1+. The patient has been gaining weight and since the first of the year has no symptoms. Naturally, the writer feels his vision may undergo more changes. However, the patient is fairly stable for the time being. As with most diabetics, if one can find the correct balance between rest, diet, and exercise, one has cleared a big hurdle.

NATIONAL BANK OF TOPEKA BUILDING
TOPEKA, KANSAS

PRESCRIBING CORRECTIVE ABSORPTION LENSES*

George P. Elmstrom†
El Segundo, California

Optometrists are frequently called upon to prescribe for patients who must, for occupational or recreational reasons, spend a considerable amount of time outdoors in bright sun light. Very often the optometrist will prescribe a very limited absorption lens with subsequent mediocre results. Patients do not necessarily have to complain about a tint, after

*Submitted on February 25, 1958, for publication in the July, 1958, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist.

all, some protection is better than none at all, and if the patient has not experienced a superb outdoor tint then there is no real comparison possible. This paper outlines methods of prescribing outdoor tints with maximum performance.

There has been promotion by manufacturers for their respective lenses based upon the relative absorption qualities for the infra-red and ultra-violet portions of the spectrum. At the same time, there has been a lack of comment on transmission alteration by thickness variation. The major reason absorption tints are prescribed is simply to reduce the glare and light to a comfortable level. The media of the eye is better protected but that is a by-product; the acuity may, or may not, be increased, and again, that is a by-product. Prescription outdoor absorption lenses are an important adjunct to the patient's regular ophthalmic correction, and must be considered a necessity rather than a luxury in many cases, especially with active outdoor patients.

A fundamental tenet in this type of vision care is the balancing of the two eyes for equal stimuli. This includes light stimuli as well as equal accommodative effort and stimuli. Prescription outdoor tints, should, the writer believes, be matched to within 1/5 of the visible transmission in order to present near-equal stimuli to each eye. When the *right* and *left* lenses vary more than 1/5, the correction is not within proper limits. As an example, if the less dense lens transmits 50% light, the other lens should not transmit less than 40%. With un-matched tints there exists a possibility that they will encourage suppression of the weaker eye. Accordingly, a study must be given to outdoor tint prescribing guides since the over-all effect of such lenses is as important to the patient's comfort and visual well being.

Perhaps the most important but least considered factor surrounds the general and specific limitations with transmission of light, versus lens thickness. With very low powers, in the area of + or — 0.50 or 0.75 transmission values are readily obtainable from the manufacturers' specifications. However, as the lens power increases, especially toward the higher lens powers, the thickness of various portions of the lens is so different that the transmission of light varies tremendously in different parts of the lens. Should one lens be convex and the other concave the problem is still greater. Figure 1 gives exact light transmission in percentage as the thickness varies for five of the most frequently prescribed outdoor tints, *green 1, green 2, green 3, Cosmetan,* and *G-15.* The greens are Rayban by Bausch & Lomb, which are almost identical to American Optical's Calobar, the Cosmetan is an American Optical Company brown tint, and the G-15 is an extra-dark grey shade

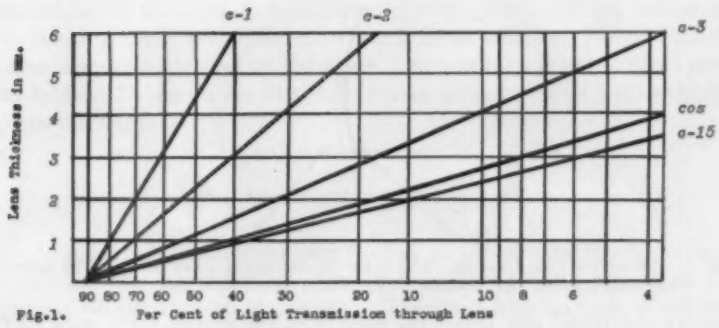

Fig.1.

used by the Air Force and manufactured by Bausch & Lomb. It must be remembered that specifications for transmission are generally given for standard plano lenses, which are the exception rather than the rule in an optometric practice.

The green lenses are generally *double density series* in construction. The G-1 lens at 2 mm. thickness transmits exactly the same white light as the G-2 at 1 mm. (or half the G-1) thickness, while this G-2 at 1 mm. thick transmits the same as the G-3 at ½ mm. thickness. Accordingly, the G-3 is four and not three times *darker* than G-1. The G-3 transmitting 31% at 2 mm. thick is considered the *"standard"* for most outdoor prescriptions.

Figure 1 is a composite graph covering the five popular outdoor absorption lenses permitting rapid and accurate transmission computation by the optometrist to determine the acceptability of a proposed prescription. Prescription lenses vary in thickness throughout the whole lens so that regular outdoor tints in the higher powers will naturally result in a finished product with a great variation in transmission. Ophthalmic lens manufacturers realizing these limitations have set recommendations as follows: with G-3 uniform lens density or absorption value is required beyond the + or — 3.00 D. in power: with Cosmetan and G-15 the accepted limits are + or — 2.00 D. It is obvious an appreciable number of patients will fall outside these very moderate limits, and the practitioner must be cognizant of alternate solutions.

The solutions to the above problems are limited, and are perhaps three in general. First, the correction may be had in uniform density laminated lenses, but the weight factor is certainly a handicap. The next possible solution would be surfacing the correction into an extra-thick lens which would not lead to such great center-to-edge

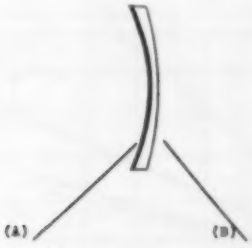

Fig. 2. Absorptive Lens Coating. (A) layer of absorption value deposited by projection of molecules under high vacuum. (B) White ophthalmic glass.

density variation, but again, the weight factor makes for a poor end-product. The third possible solution is the use of the absorptive coating placed on the ocular side of the corrective white lens, as in Figure 2. This coating is extremely thin and hard. The limitation of the absorptive coating with glass lenses is the availability of but one shade, brown, and four variations of that tint. The advantage is obviously the uniformity of transmission throughout all parts of the ophthalmic lens. In high powered prescriptions this coating is available by a number of laboratories throughout the country. It is suggested that the reader secure the proper spectral-transmission charts on any particular coating considered.

INSTRUMENT REVIEW

DIAGNOSTOR BY NATIONAL ELECTRIC INSTRUMENT

A desk or wall unit which holds two diagnostic lamps and provides them with controlled power through retractable cords, is being put on the market by National Electric Instrument Division, Engelhard Industries, Inc., Elmhurst, Long Island, New York.

The molded plastic housing has sockets which can hold an otoscope and an ophthalmoscope securely, yet handy for use. For opthalmologists and optometrists, the otoscope can be replaced with a retinoscope. Called the "National Diagnostor," the new device will be convenient for practitioners who must use these instruments frequently. Reeling in and out automatically, the 7-foot cords can be locked at any point along their length, so that there is neither pull upon the instrument while it is in use nor unwanted slack. After the Diagnostor as a unit has been turned on, the power going to each instrument is controlled

separately by means of two illuminated dials. These are self-indicating, eliminating the conventional sweephand meter entirely. Neither instrument lamp actually goes on, however, until the instrument is lifted from its socket. Dropping the instrument back into its socket automatically turns off its light.

NEAR-POINT TEST CARD

Students at the Los Angeles College of Optometry have developed a card for near-point testing. Due to its unique construction it affords fineness of detail with durability. Targets which include a reduced Snellen chart, circular test objects for crossed cylinder tests, vertical and horizontal grids, vertical line of 20/30 letters, horizontal line of 20/30 letters, and a modified Thorington test for vertical imbalance are photographically reproduced on a rotating disc. The reverse of the card is utilized for measurement of lateral phorias by the modified Thorington technique. A durable flat finish, plastic lamination insures cleanliness since it may be washed. Inquiries should be addressed to Bookstore, Los Angeles College of Optometry, 950 West Jefferson Boulevard, Los Angeles 7, California.

SPRING-TENSIONED SCREWDRIVER

A screwdriver has been designed for use for anyone who works with miniature screws. This tool contains a spring-tensioned, pointed plunger which runs through the bit to exert a steady pressure upon the small screw or piece part. This insures positive seating, whether or not there is a hole in the screw slot. The bit is double-ended, with two sets of points, one set on either end. These case-hardened bits will accommodate the end of practically all miniature screws. The tool is easy to use, in confined spaces. The screwdriver is knurled for almost its entire 4½ inch length for the surest grip possible. The handle is also equipped with a rotating knob which permits the screwdriver to turn easily in the hand as it is used. This screwdriver is made by the Suttle Equipment Corp., 135 S. LaSalle St., Chicago, and may be ordered through your laboratory.

BOOK REVIEWS

SURVEY OF OPTICAL AIDS SERVICE. Published by the Industrial Home for the Blind, 57 Willoughby Street, Brooklyn 1, New York. 47 pages, 8 tables, 3 illustrations, Board covers. $1. 1957.

The Industrial Home for the Blind has long subscribed to the policy of encouraging its blind clients to make maximum use of residual sight. For example, as early as 1942, the IHB set up a pilot demonstration of adequate light, glare- and shadow-free surfaces, and the use of contrasting colors for providing maximum visibility. To encourage clients and staff members who could safely and profitably make use of magnification and to assist them in attaining satisfactory magnifiers, this was but another step in the application of this policy.

In January, 1952, the IHB undertook a pilot study of the effectiveness of optical aids for clients whose corrected visual acuity was less than 20/200. For the study, a wide selection of magnifiers were employed and the client permitted to make a choice on a trial and error basis. The results of this study were so gratifying that after consultation with leading ophthalmologists and optometrists, the IHB decided to expand its rehabilitation program to include an Optical Aids Service for blind persons with residual vision. The agency obtained for refraction and fitting of optical aids, the part-time services of Dr. George O. Hellinger, a Brooklyn optometrist who for some time had been giving special attention to low-vision cases.

The Optical Aids Service was inaugurated in March, 1953. The services are offered to any resident of Brooklyn, Queens, Nassau or Suffolk counties who comes within the legal classification of blindness, and for whom an ophthalmological report shows that there is no likelihood of improvement by medical or surgical procedures and that the use of magnification is not contra-indicated. Another requirement is that the client express a clear desire for the service.

A report on the first 500 cases processed between March, 1953, and December, 1955, by the IHB is provided in the monograph "Survey of Optical Aids Service." The analysis of the data was made chiefly for the purpose of (1) determining how many individuals had been helped by the optical aids, (2) learning what use the clients were making of their appliances and what the increased use of their vision meant to them, and (3) discovering ways in which the service might be improved and determine areas which call for further exploration. No one doubts the importance of these objectives and the fact that they have been achieved and the answers now are available is very significant.

The tabular and statistical analysis of pertinent data represents a valuable contribution in the book; also of great importance is the description of the Otical Aids Service of the IHB itself. From it, the necessity for teamwork between the social worker, the vocational counselor, the ophthalmologist and the optometrist in rehabilitation becomes very evident. This section of the book in particular was written with remarkable insight and clearly manifests the sound background and principles which underlie this optical aids service.

In meeting the visual needs of most patients the optometrist rightly feels that he can quite adequately go it alone. For those with very limited vision, however, such an approach is altogether inadequate. This little book beautifully describes the experience and results of one program to meet this problem; it is a hope that others will follow presenting different viewpoints. In any event, the report deserves serious study by all optometrists contemplating work in rehabilitation of the blind.

V. J. ELLERBROCK, PH.D., O.D.

SCHOOL OF OPTOMETRY
THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO

GUIDE TO OCCUPATIONAL AND OTHER VISUAL NEEDS. Clark Holmes, Harry Jolliffee, O.D., and James Gregg, O.D. Published by the Independent Optical Wholesalers Association, 222 West Adams St., Chicago. 477 pages, illustrated, cloth. $15. 1958.

This book was written for the modern practitioner who believes that spectacles should be prescribed on the basis of occupation, avocation and general wear; the idea being that one particular lens combination is not always suitable for the full range of an individual's activity. It contains 477 pages, divided into sections on How These on Job Studies Were Made; A Collection of Scientific Data to Aid in Prescribing for Occupational Needs; Modern Multifocal Lenses and finally a section on Analysis of Occupations and Avocations; the latter section constituting the bulk of the book. In discussing each occupation and avocation, the following points are considered: Description of Occupation; Analysis of Visual Tasks; Qualifying Visual Factors; Other Factors Affecting Lens Prescription; Prescribing for Occupational Needs, and Solution to Other Visual Problems. Several close-up photographs are supplied with each discussion, showing typical working positions.

Most younger optometrists, including this writer, have gone

through the process of going out on patient's jobs to take careful measurements, observations, etc., and in a due course of time assembled material designed to be of help in the examination of certain presbyopic patients. This book does all this and more and can be of tremendous help if we bear one thing in mind, namely, not to allow material in the text to take the place of professional judgment.

JOHN W. HIER, O.D.

903 MARQUETTE AVENUE
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THE HUMAN EYE IN ANATOMICAL TRANSPARENCIES. Gladys McHugh, Peter C. Kronfeld, M.D., and Stephen L. Polyak, M.D. Published by the Bausch & Lomb Optical Company, Rochester, New York. Fifth Edition. 1958.

The fifth edition of *The Human Eye in Anatomical Transparencies* has been published by Bausch & Lomb, Rochester. This book has been in continuous demand from students, educators, and professional men since it was first published in 1944.

A unique method of pictorial reproduction known as "Trans-Vision" has been used to picture the complicated mechanism of the human eye. The "Trans-Vision" section of the book contains 34 full color anatomical paintings of the normal eye by the medical illustrator, Gladys McHugh, University of Chicago. Each page provides a frontal view and a temporal view of the eye and its surroundings so that all features are in proper perspective and retain their true anatomical relationship. The serial dissections on each page isolate the separate parts of the eye for detailed study. Where there is natural stratification, the structures encountered are removed layer by layer in the sequence in which they would present themselves to the dissecting knife. On the reverse side of each sheet is the back view of the dissected layer. The drawings are reproduced at twice the actual size of an adult eye to show all details clearly. A simplified description is provided with each anatomical illustration.

The main text is written by Peter C. Kronfeld, M.D., associate professor of ophthalmology, University of Illinois. This text has been so organized as to present not only a systematic account of ocular anatomy, taking up the various structures in a functionally logical order, but also a separate topographic treatment of the anatomy as it presents itself in the "Trans-Vision" anatomical paintings. The text is augmented by a number of original drawings in addition to the reproduction in one color of the "Trans-Vision" paintings, which are labeled to correspond with text references.

A history of our knowledge of the human eye is given in the third section of the book. This has been prepared by Stephen L. Polyak, professor of anatomy, University of Chicago. His approach traces our knowledge of the eye from early Greek begininngs (before 300 B.C.) to the present.

DAVID TEMPLEMAN

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CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

PURVIS HEADS AMERICAN OPTOMETRIC ASSOCIATION

At the annual Congress of the American Optometric Association, Shoreham Hotel, Washington, D. C., June 28, Dr. Hoyt S. Purvis, Jonesboro, Arkansas, president-elect for the past year, took over the top spot from Dr. Lester H. Sugarman, Meriden, Connecticut. Dr. Sugarman will now serve on the Board of Trustees as immediate past-president. Others elected officers and trustees are: Dr. P. N. DeVere, Morgantown, North Carolina, president-elect; Dr. Richard C. Schiller, Marshalltown, Iowa, vice-president; Dr. H. Ward Ewalt, Pittsburgh, secretary-treasurer; Dr. Harold M. Fisher, New York City, trustee; Dr. Don A. Franz, DeKalb, Illinois, trustee; Dr. C. R. Haser, Butte, Montana, trustee, and Dr. J. Herman Thomas, Fort Worth, Texas, trustee. Approximately 1,100 persons were registered at the Congress which was reported as being one of the most successful in recent years. The 1959 A.O.A. Congress will be held in Dallas next June.

MICHIGAN CHAPTER-AMERICAN ACADEMY OF OPTOMETRY

The Spring meeting of the Michigan Chapter was held April 24 at the Kellogg Center on the campus of Michigan State University, East Lansing. Dr. Joseph Sasaki, Ann Arbor, presented a paper, "The Theoretical, Factual and Practical Approach to Diagnostic Optometry," during the morning session. Dr. S. Howard Bartley, professor of psychology, Michigan State University, presented a paper on "Relationship of Optometry and Vision to Psychology," in the afternoon. Dr. Clarence D. Omans, Battle Creek, was elected chairman; Dr. F. Milton Hathaway, Pontiac, vice-chairman, and Dr. C. L. Scholler, Big Rapids, secretary-treasurer.

NORTHEASTERN OHIO CHAPTER-AMERICAN ACADEMY OF OPTOMETRY

The Northeastern Ohio Chapter elected the following officers at the May meeting in Cleveland. Dr. George F. Jones, Salem, president; Dr. Paul A. Wilkinson, Wellington, vice-president; and Dr. Kenneth A. Hoose, Kent, secretary-treasurer. The officers and the following members constitute the Executive Council: Dr. Lois Bing, Shaker Heights; Dr. Joseph E. Fitzgerald, Cleveland, and Dr. Kenneth G. Robinson, Medina. At this meeting two committees were appointed. The first, to investigate the matter of fitting hearing aid spectacles and the problems involved, and the second, to assist applicants in meeting their requirements for Academy membership.

SOUTHWEST CONTACT LENS SOCIETY FORMED

The Southwest Contact Lens Society was organized at Waco, Texas, during the meeting of the Contact Lens Congress June 7-9. The Society will promote further graduate education and research in the field of contact lens fitting. The Society will use optometric contact lens specialists to teach optometrists in general optometric practice the many facets of contact lens fitting. Dr. Herman H. Gerdes, Jr., was elected president. Other officers are Dr. Irving Brodsky, vice-president; Dr. Carl Dean, secretary, and Dr. E. E. Crume, treasurer. One of the first actions of this new Society was to contribute $1,000 to the Foundation for Education and Research in Vision at the College of Optometry, University of Houston, Houston, Texas. The third Southwestern Contact Lens Congress will be held in Waco in March, 1959.

NEWS FROM SUPPLIERS

Petersburg, Va. Titmus announces that it has awarded the first of a series of four-year scholarships for a career in optometry to Robert S. Glover, Huntington Woods, Michigan.

Dayton, Ohio. Univis has installed the new IBM electronic RAMAC system to speed sales and accounting data through their plants.

Chicago. The Plastic Contact Lens Company announces that the Wesley-Jessen Contact Lens Company of California has been formed and offices opened in Los Angeles to serve as distribution and service center for the company on the Pacific Coast. The company will also hold Contact Lens Seminars in eleven Canadian cities July 9 through August 11.

Southbridge, Mass. American Optical Company announces the release of its new 36-page 1958 *Ophthalmic Materials Catalog*, in conjunction with the celebration of its 125th anniversary. Departing from the company's custom of issuing individual catalogs for each of its product groups, the 1958 catalog combines frames, lenses, cases, outdoor

glasses, and Monoplex eyes under the all-inclusive heading of Ophthalmic Materials. The American Optical Company has also released its *1958 Survey of State Requirements for Motor Vehicle Operators*. Of particular interest to optometrists are the figures on requirements for re-examination of eyes for renewal of licenses.

Rochester, N. Y. Bausch & Lomb has introduced two new straight-top Orthogon bifocal lenses, the ST-25 and ST-28. These new bifocals have 25 and 28 mm. segments to provide large reading fields. The company also announces production on a new optical gage that reads direct to .0001" over a three-inch range on an illuminated and magnified scale.

Rochester, N. Y. Shuron announces the distribution of new large size (6"×11½") job trays made in three colors: red, green and yellow, of unbreakable styrene plastic.

Indianapolis, Ind. The CONTINENTAL DIGEST carried a story showing Dr. Merrill J. Allen using a new instrument for measuring phorias and ductions at the clinic of the Division of Optometry, Indiana University.

The style aspects were emphasized during the month through new spectacle frames by American Optical Company, Bausch & Lomb, Continental, Liberty, Marine, Shuron and Titmus. In addition, Opticase has brought out a new Spectrapurse in five colors for women. Vision-Ease has announced a new lens with a neutral gray absorption tint for sunwear and the Younger Manufacturing Company announces new improvements in their seamless bifocal.

NEWS BRIEFS

Dr. Theodore A. Brombach, San Francisco, was appointed director of the Distinguished Service Foundation of Optometry at a meeting of the Advisory Council at Forest Grove, Oregon, on May 25. The meeting took place at the time of the commencement program of Pacific University. . . . Dr. Herman Sager, supervisor, Eye Service, Sperry Gyroscope Company, Great Neck, New York, spoke on "Head and Eye Protection" at the 28th Safety Convention and Exposition of the Greater New York Safety Council. . . . Dr. E. B. Alexander, executive director, Optometric Extension Program, has announced the distribution of a series of papers on ocular pathology. These have been written by Dr. H. W. Bloom, faculty member of the Los Angeles College of Optometry.

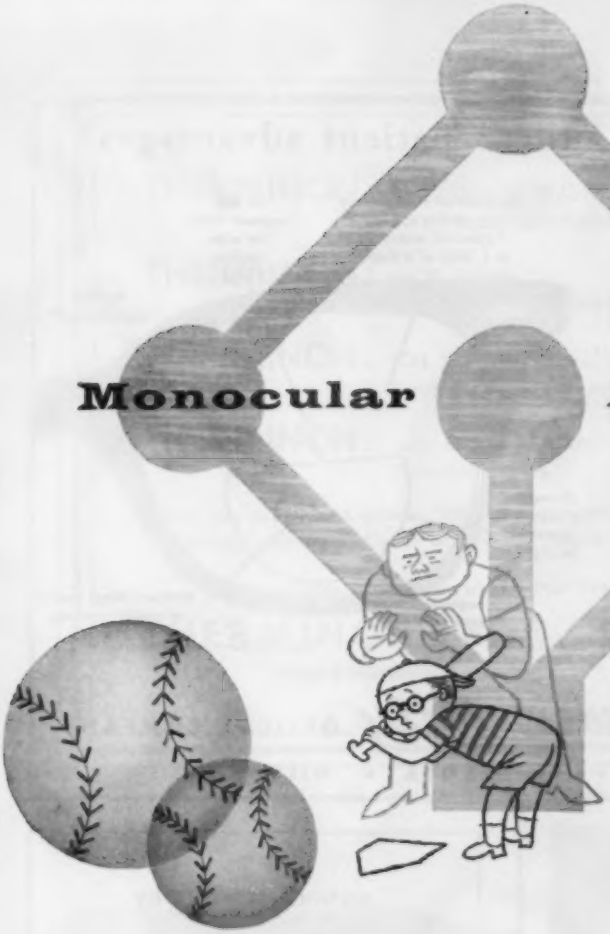
From three of our colleges during June we received word that commencement speakers were Dr. Robert Tubesing, president, American Academy of Optometry at the Pennsylvania State College of Optometry,

Philadelphia; Dr. Lester H. Sugarman, president, American Optometric Association at the Massachusetts College of Optometry, Boston, and Mr. William P. MacCracken, Jr. Washington representative for the American Optometric Association at the Illinois College of Optometry, Chicago. . . . Dr. Robert E. Bannon, American Optical Company, Buffalo, presented a forum on the correction of aniseikonia at the Massachusetts College of Optometry on June 5. . . . The Illinois College of Optometry also announces the Getman Award for the graduating student presenting the most original report dealing with "Vision, The Dominant Factor in Human Behavior." This reward will be $100 each year.

The Better Vision Institute points out that Fashion, Function and Obsolescence are factors which are bound to increase the flow of patient traffic to optometrists' offices. . . . Dr. A. N. Haffner, director, Optometric Center of New York, has announced the receipt of two grants-in-aid from the Winfield Baird Foundation and the Crippled Children's Friendly Aid Association for visual and orthoptic care for indigent children. . . . Dr. Ernest A. Hutchinson and Dr. William M. Ketchum were awarded Honorary Doctor of Ocular Science Degrees by the Los Angeles College of Optometry at the commencement program in June. Dr. Hutchinson is former dean of the college and Dr. Ketchum is a former president of the Board of Trustees. Both are now in retirement. . . . Mr. E. H. Titmus, Jr., president, Titmus Optical Company, Petersburg, Virginia, was awarded an Honorary Doctor of Ocular Science Degree at the commencement program of the Massachusetts College of Optometry, Boston, on June 14. In conferring the degree, Dr. Ralph H. Green, dean of the college, lauded Mr. Titmus for his humanitarian interests and considerations of the profession toward better eye care.

The Bausch & Lomb Honorary Science Award program marked its 25th anniversary June 17 with a luncheon before a group of scientists and educators at the Sheraton-Carlton Hotel, Washington, D. C. Mr. Carl S. Hallauer, president of B. & L., delivered the address of welcome. Vice-President Nixon spoke and presented special awards to two high school seniors who represent 1958 winners of the Science Award chosen in more than 6,000 secondary schools in the United States.

Monocular Aphakia



The disparity in image size between the aphakic and non-aphakic eye is quite great. Divergent strabismus often results if the eyes are left visually uncorrected. If a spectacle lens is applied, due to the magnifying properties and the large prismatic displacement away from the optical center of the lens, fusion will usually be broken. A contact lens eliminates the prismatic effect by maintaining its position on the cornea even when the eyes are moved; by virtue of being located closer to the entrance pupil of the eye, the contact lens minimizes the image size disparity; thus the contact lens is one of the few means of maintaining binocular vision for the monocular aphakic.

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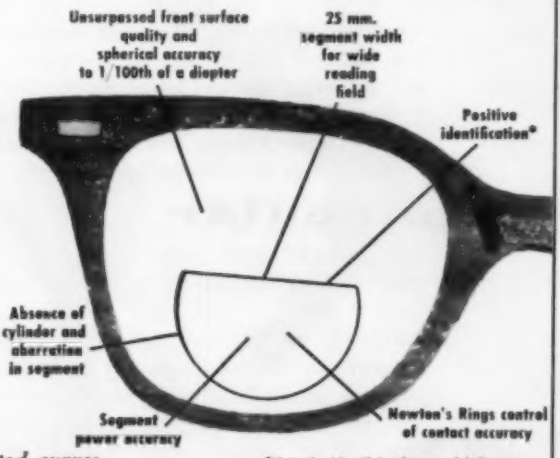
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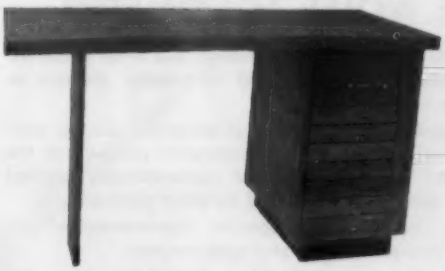

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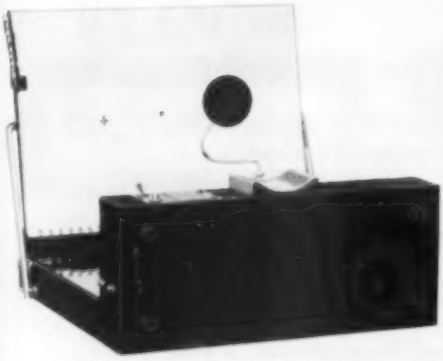

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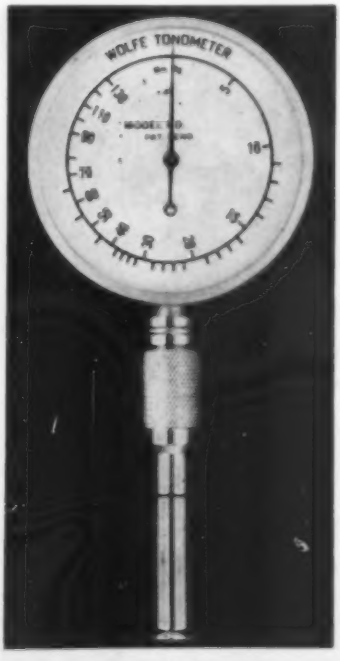

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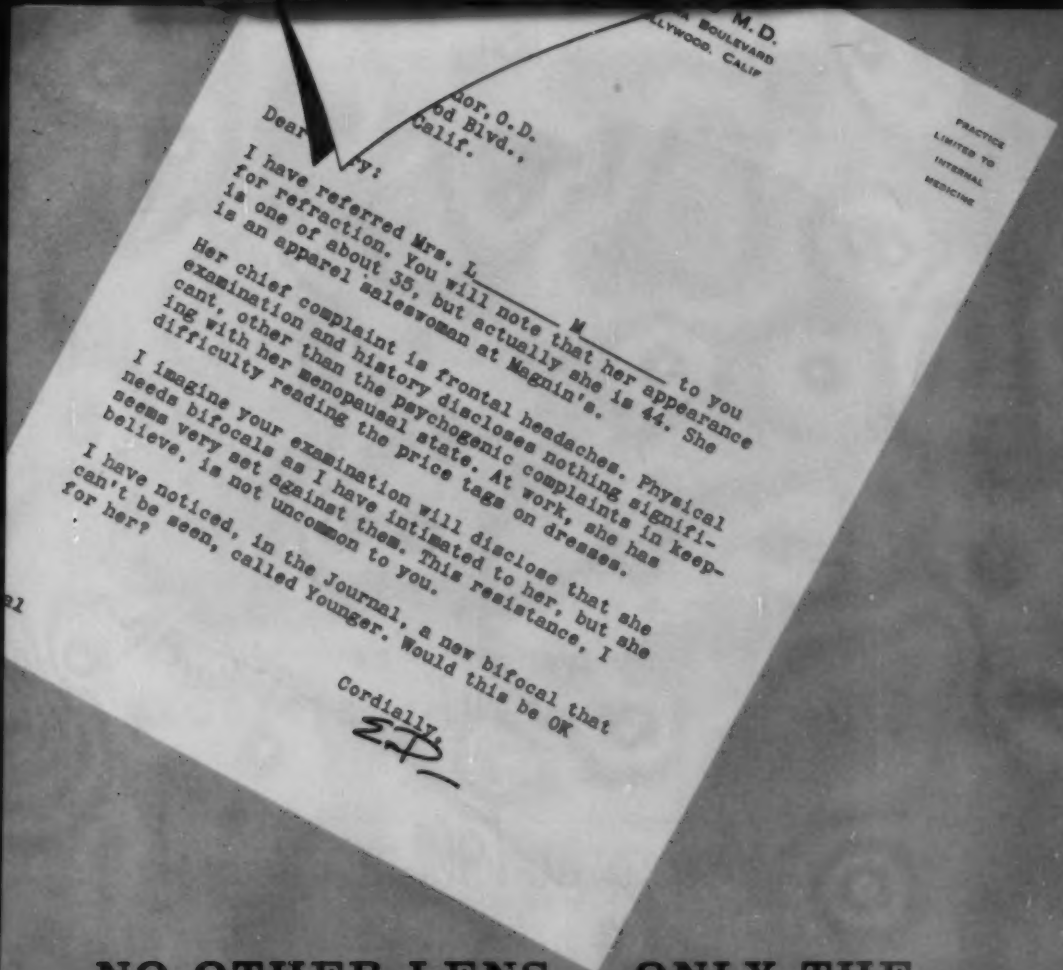
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PRACTICE LIMITED TO INTERNAL MEDICINE
Dear
I have referred Mrs. L
to you for refraction. You will note that her appearance is one of about 35, but actually she is 44. She is an apparel saleswoman at Magnin's.
Her chief complaint is frontal headaches. Physical examination and history discloses nothing significant, other than the psychogenic complaints in keeping with her menopausal state. At work, she has difficulty reading the price tags on dresses.
I imagine your examination will disclose that she needs bifocals as I have intimated to her, but she seems very set against them. This resistance, I believe, is not uncommon to you.
I have noticed, in the Journal, a new bifocal that can't be seen, called Younger. Would this be OK for her?
Cordially,

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